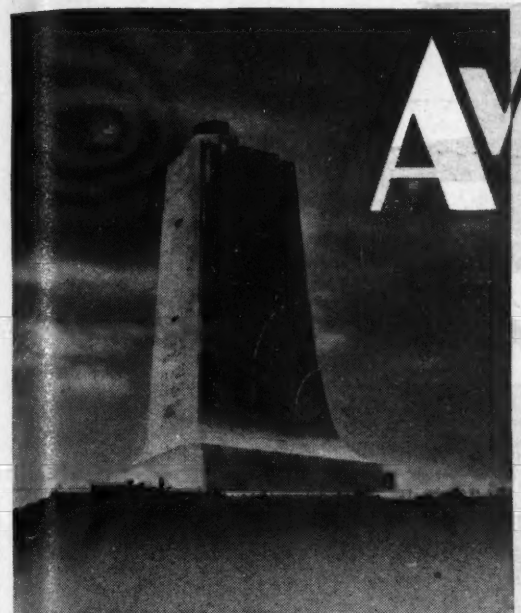

AVIATION

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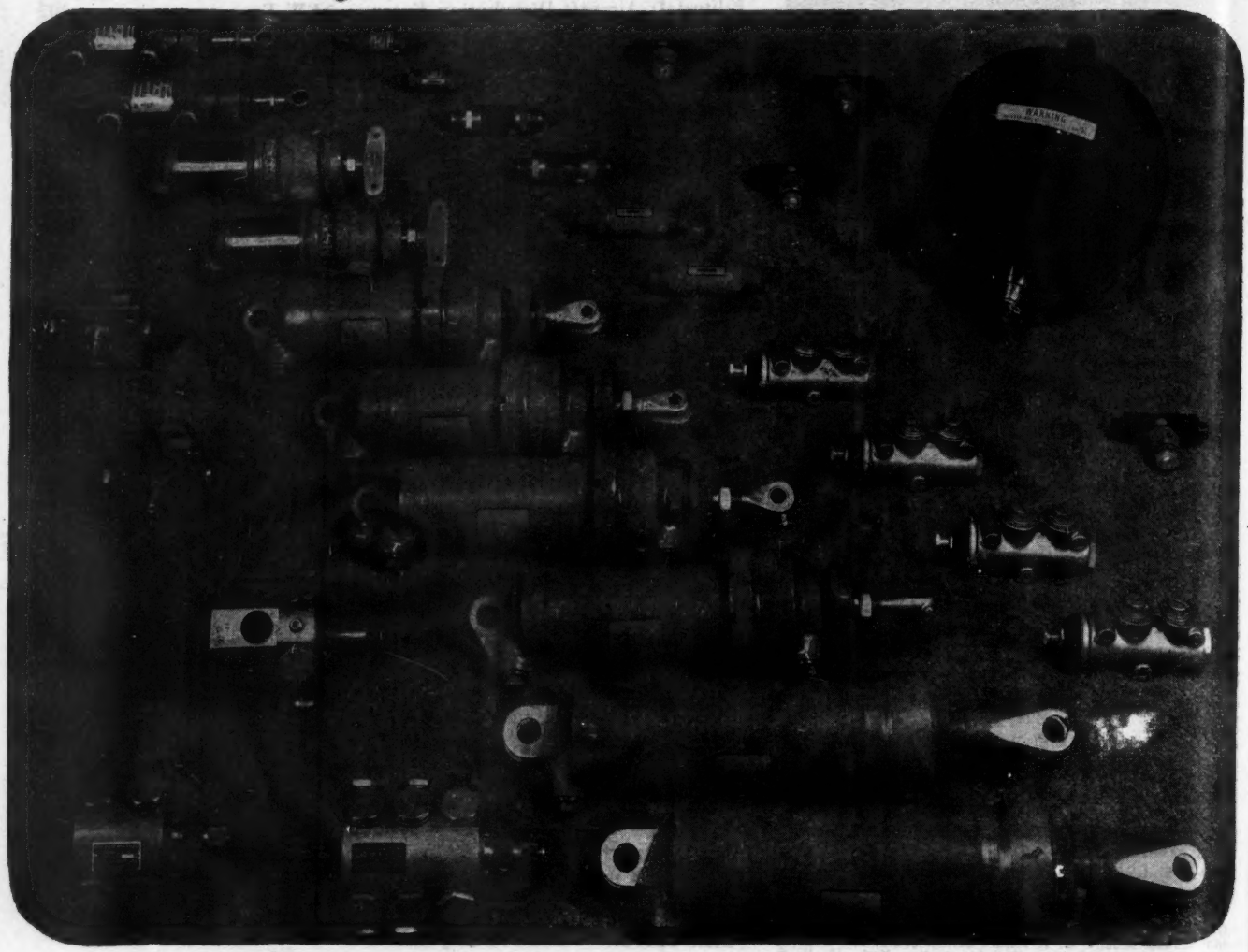
Muscles for the Black Widow



SPIDERS have muscles, too—these are the muscles for the Black Widow. Thirty Altair hydraulic units are used in the spectacular Northrop P-61 Black Widow. Pacific Division is justly proud that the entire hydraulic system incorporates and is built around these actuating cylinders and component controls that form the muscles on the world's largest pursuit planes designed specifically for Night Fighting. Pacific Division, Bendix Aviation Corporation, 11600 Sherman Way, North Hollywood, California.

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

Airplane Photo, Northrop Aircraft, Inc.

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Briefing for September

LYLE L. PIERCE, Boeing's master layout supervisor and project engineer under whose direction early B-17's were designed, who gives details (page 148) on Boeing "Grid Machine," an ingenius unit used for master layout drawings—a unit that helped get B-29's as well as B-17's into the air in a hurry.

Ideas to make better airplanes are likely to be found anywhere—from the experimental department clear out to the most remote combat zone—and that's just the scope AVIATION will cover getting material to go into a brand new department,

For Better Design, which makes its bow this month on page 119. The articles and illustrations presented will not only aim at just as wide a scope but, as they build up into a constantly-usable handbook of experience, they'll have one common purpose: To create finer airplanes.

J. Carlton Ward, Fairchild's prexy, has had better opportunities than most men to study the full effects of air power policies. Fortunately for this country he's the type of clear thinker who takes advantage of such opportunities—and the result of his studies, a sound program that might well be our national policy, is set forth in his provocative article beginning on page 108.

Before the war, Al Bennett was one of the "hottest" airplane salesmen the industry ever saw. And, in really putting aircraft sales on a volume basis, he learned a lot of things to do, as well as *not* to do. Now, as Director of Sales for Aeronca, Al is putting all his experience to work in a program that's destined to mean business independence for a lot of returning war veterans and others who want to be personal plane dealers. His plan and first photos of two new Aeronca planes are presented for the first time on page 116.

Can the airport become a definite part of a community's business life? It not only can, it should, says Melvin H. Nuss. And he should know for, as secretary-manager of the Reading, Pa., Airport Commission, he's welded flying facilities to both city and county industrial activity. He tells how it was done on page 112.

Top-priority for electrical engineers is development of alternating current systems for large aircraft. Beginning on page 123 is a detailed and timely discussion of electrical system performance factors required for present-day planes and how a.c. is adaptable to service needs.

Another first is that on page 128, revealing details of the Kollsman Machmeter, the instrument developed to measure safe top limits of planes that approach sonic speeds in level flight or, as some of them do, get over that "hump" in maneuvers. Explained fully are both underlying theory and operating principles of what may soon become a basic "must" instrument.

"Save money by spending it" may sound like the neatest trick of the week. But Ralph Upson says you can do it by spending the money on flaps and retractable landing gear when building small aircraft—even those that cruise at no more than 100 mph. His analysis, which would take these two items out of the "extra" class, is presented on page 130.

There's meat for both production and maintenance men in R. A. Livingston's article on page 156, for it gives the all-important do's and don'ts for installation of aircraft tubing.

Winter's not far away, which means that cold-weather maintenance problems are just as close. Alaska Star Airlines' C. O. Carey has been through plenty of tough winters and, in his story on page 160, he gives the benefit of his long experience in conquering some of the world's toughest weather and keeping planes flying on schedule.

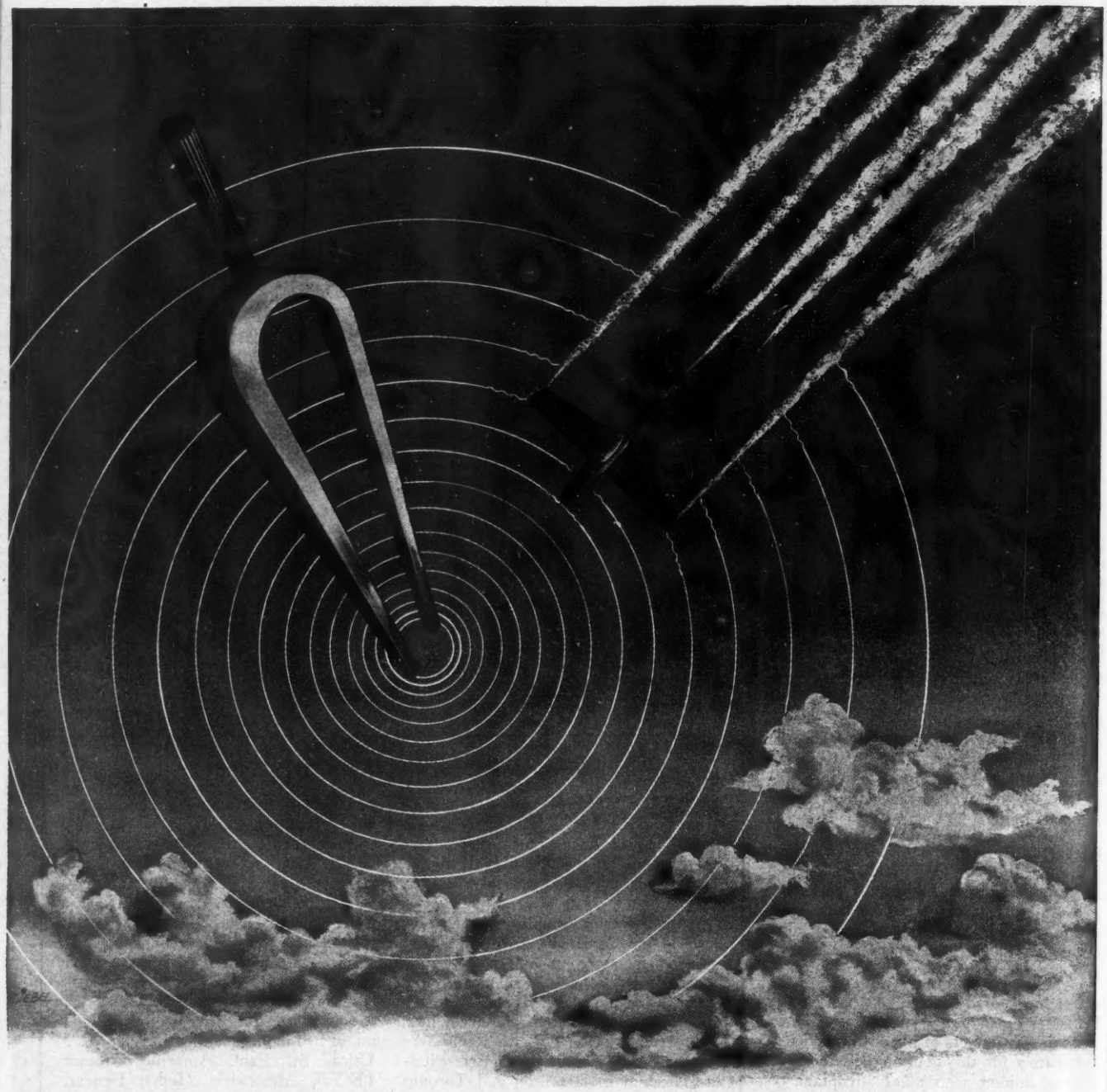
The British-designed Miles 35 pictured on page 217 of our July issue created a lot of interest among flying people. So, on page 181, we present Mr. Miles' own arguments for the tandem-wing type of craft—what he thinks can be done with it both commercially and militarily.

Down the Years in AVIATION'S Log

25 Yr. Ago (1919)—New 24-cylinder engine successfully tested at McCook Field . . . Two London-Paris airlines started . . . Aeromarine flying boat drops mail on deck of *Adriatic* . . . London *Daily Graphic* announces proposed airline combine financed by several governments . . . San Francisco has inter-city air taxi service . . . *Bodensee,* new Zeppelin, is first to have hot and cold water service for passengers . . . Curtiss announces new routes from New York to Rochester-Syracuse-Utica-Albany; Erie-Pittsburgh; and to Hamilton and Toronto . . . Navy offers F-boats for sale to civilian boaters . . . Air Department proposed to handle all defense and commercial aviation.

15 Yr. Ago (1929)—Consolidated acquires Fleet and Thomas-Morse companies . . . National Air Races use radio plane for traffic control . . . Nineteen women flyers race from Santa Monica, Cal., to Cleveland Air Races . . . Curtiss-Wright announces $9,123,887 unfilled order backlog, 73 per cent increase over year ago . . . Anderson, Ind., prosecutor starts campaign against unlicensed tyro pilots . . . Kellett starts building factory at Camden to manufacture autogiros under Pitcairn-Cierva license . . . Engine manufacturers now number 23, aircraft 101, total employment 22,000 persons . . . ACCA discusses aircraft spinning tests . . . Minneapolis Law College offers air law course, and New York University has Guggenheim course for ground school teachers . . . After seven years, Dr. Hugo Eckener obtains U.S. patents for Zeppelin type airship . . . Kansas City fly-it-yourself firm rents planes for $15 an hour. PAA extends overseas service to Guatemala, Curacao, and Paramaribo . . . Colonial Air Transport commences Boston-N.Y. run . . . Montreal-Detroit airmail flies 61,562 mi. in two months without mishap . . . Utica, St. Paul, Amarillo, Homer (N.Y.), Alexandria (Ind.), Denver, open airports this month . . . TAT opens direct San Francisco service.

10 Yr. Ago (1934)—Washington conference revises airline safety regulations . . . Swissair uses Lockheed *Orion* for Balkan mail service . . . Dept. of Commerce opens bids for light plane manufacture . . . Rep. Vinson proposes 2,184 Navy planes but Navy cuts figure to 1910 . . . National Air Races, National Balloon Race, and Women's National Air Meet are scheduled this month, and Gordon Bennett Balloon Race is slated at Warsaw, Poland . . . Construction starts on carriers *Yorktown* and *Enterprise,* and *Ranger* sails on shakedown cruise to Rio . . . Air France mail plane *Arc-en-Ciel* makes fourth South Atlantic flight to Brazil . . . East River *Skyports* installed at foot of Wall St. and E. 34th St. N.Y.C.



THE NEW KOLLSMAN MACHMETER is an instrument which gives a pilot advance warning when his plane approaches the speed of sound—a speed at which an entirely new set of aerodynamic conditions—and dangerous ones—is introduced into the operation of a plane. Since the occurrence of this critical speed varies with altitude and the particular type of plane being operated, an indication of its approach is important for the testing of aircraft. The new Kollsman Machmeter is typical of the special flight test instruments which have been developed by Kollsman for America's Aircraft manufacturers.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

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ELMHURST, NEW YORK • GLENDALE, CALIFORNIA

Aircraft Distribution Enters a NEW Era

ONCE UPON A TIME there was a very brilliant engineer who designed a wonderful airplane which flew like an angel and was very easy on the eyes. He showed it proudly to his friends and each one said, "That is the only plane for me. I should like so much to buy one." And so, each night, the brilliant engineer went to his slumbers happily because he believed his accomplishments to be successful.

Since the world was then in one of those periods when inflated money was bursting through the doors of all the treasuries and burning holes in peoples' pockets it was not very long before the brilliant engineer became possessed of a financial angel who put up the cash to build more airplanes like the first. Soon a goodly number were completed. The brilliant engineer sat comfortably in an office with "President" written on the door, waiting in vain for the return of those good friends who had wanted so much to buy these planes. In due course the angel grew tired and flew away to sounder investments. Another airplane company had bitten the dust.

THIS PARABLE is neither exaggerated nor is it an isolated incident in the history of airplane manufacturing. It has happened, with minor variations, in dozens of instances. It's typical of the first phase of aviation merchandising.

The unhappy truth is that many a pioneer manufacturer failed because he believed that bunk about building a better mousetrap and having the customers beat a path to your door.

With the advent of the light airplane came a new generation of distributors who knew something of the basic principles of merchandising. The more progressive manufacturers learned that they must allow for sufficient discounts in their price schedules to attract responsible distributors and dealers. A healthy rise in personal aircraft sales was interrupted by the war.

Now we are entering another new period in aircraft distribution. For many months AVIATION has been presenting material designed to help manufacturers in their postwar planning. In this issue (page 116) we offer pictures of the first of the crop of new postwar airplane models along with one of the first distribution programs to be formulated in the personal aircraft field.

THE PLAN is based upon sound prewar experience and tailored to fit the needs of our postwar national economy. It does more than sell airplanes. It sells young men and returning veterans the opportunity to find employment in an attractive new business. Thus it contributes to the solution of the critical unemployment problem that lies ahead, and by increasing personal flying it promises to add to the fuller life that can be ours if we possess the wisdom to achieve it.

These basic factors are the major ingredients of the American enterprise system under which this country has reached its present stature. The plan is one of the first indications of the revival of the system to which we have devoted our energies in both peace and war—the system to which we must direct redoubled energy after the war.

Manufacturers and distributors of airplanes or equipment and those who hope to enter this field should study the principles of this plan and apply them to their own businesses.

Leslie E. Neville

EDITOR

AIRPOWER CAN MEAN NATIONAL SECURITY

By **J. CARLTON WARD, JR.,** *President, Fairchild Engine & Airplane Corp.*

Maintaining the peace requires eternal vigilance, which can be had with least expense through an adequate air force. Here is a program—which might well become national policy—for continuing research and development necessary to keep air supremacy.

TECHNICAL DEVELOPMENT is the key to American airpower, present and future. In our national interest, what are the broad facts in this particular, and what should be our country's policy?

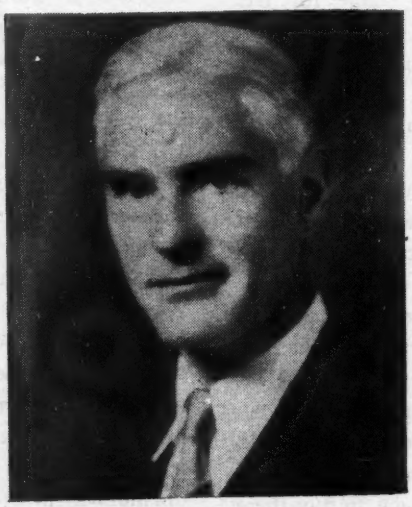
History shows that many great inventions have been developed and perfected by various nations, to the detriment at times of the nation that originally produced the fundamental development or conception. For example, America produced the first airplane in 1903, but in World War I it was compelled to fight in airplanes produced by its allies, and for years the original American invention of the first flying airplane has rested in a British museum.

Similarly, the principles of radar were first announced to the world in the United States as early as 1922 by two Naval scientists in the laboratory at Anacostia, D. C. Yet radar was developed primarily by Sir Watson Watts in Britain and handed back to us after we became her fighting ally and after we had been given time to prepare ourselves for the present struggle with the time purchased by her effort. It is interesting to note that Sir Watson Watts was knighted for the work which he did in that preparatory effort; the two naval scientists are known only to a few.

In another case, the U. S. Navy, in the spring of 1918 in cooperation with the Sperry Corp., launched a successful flying bomb at Bellport, L. I., carrying 1,000 lb. of TNT. with a 400 mi. range. It had many features of the present German robot bomb.

At the same time, Charles Kettering and his associates began the development of radio controlled flying missiles which they believed could assist in preventing future wars. It was left to the Germans, a quarter of a century later, to put this weapon into their own concept of total war. Such instances can be multiplied many times.

At the expiration of World War I, France emerged as the leading air power in the world, for she had more airplanes, more facilities, and more technicians than could then be found in any other country.



J. Carlton Ward, Jr.

—who was an eye-witness to the fall of France. As a member of an aviation mission in 1939 he was in a unique position to see industrial decay which preceded that nation's collapse. In the light of his first-hand information, his warnings against nationalization of industry and stagnation of research and development are particularly pertinent today.

But from that date on she declined steadily, not only in relation to other powers, but also in an absolute degree.

From the outside it appeared that France rested on her laurels. Being a thrifty nation, she seemed to feel that possession of a quantity of airplanes met the needs of the situation. Subsequently her industry became a political football and attempts were made as late as 1939 to nationalize it under a socialist government. And so, as World War II approached, France found herself with politically dominated facilities which her government, in the throes of war, admitted were inefficient and wasteful.

At that time I was head of a mission to the French government to promote production, and the first job to which we were assigned had to do with their worst headache, the nationalized Lorraine-Detrich engine factory. Production standards were lower in the nationalized industry then had been the case under private management.

An excellent article (see page 56, Jan. 1942, AVIATION) written by an American who lived through that period in France, carefully sets forth those factors that undermined France's effort in preparation for the war.

The lessons to be learned from French experience are clear. They are:

1. Possession of the most airplanes at a given moment does not, *per se,* mean realization of continuing development nor the successive production of improved models.

2. Private industry, with its competitive aspect, surpasses to a marked degree the performance of government-owned facilities.

3. Merely to be confronted with a national emergency does not solve the problem. In the instance of World War II, France was not given time enough to work herself out of her inferior position.

Before turning to America's position, it might be well to examine that of Germany, popularly regarded as a nation of vast technical resources and possessed of ample skilled labor and engineering talent. Even under Hitler, her factories operated under private management, but with governmental direction as to basic policy and, in many instances, government participation in the ownership. The government owned 50 percent of the great Junkers Works, but in spite of that ownership, permitted the operations to be carried on by private management. Being a totalitarian state, the basic policies were laid down for the various manufacturers by the government.

In 1933, Germany started active preparations for World War II. Ample facilities and money were provided by government for production and for research and development. While a smaller country than our own, her appropriations for aircraft production were tremendous as compared with ours; under her rearmament program her funds for research and development were many time those available here in our own country.

Americans who inspected the DVL Laboratories—and they were many, because the Germans at that time were free in showing them to us—all brought back reports on the tremendous facilities that the totalitarian government had provided for this one job of getting the most and best airplanes.

As a result, when World War II began, Germany had produced the greatest quantity of then-modern aircraft the world had ever seen. However, there were near-fatal mistakes made in the German preparations for war in the air—mistakes that stemmed from over-all powerful governmental direction. These mistakes were: First, her assumption that airplane models should be frozen in order to produce in quantities, as soon as a satisfactory design had been evolved (this produced static designs of airplanes, modern at the start which, in the early stages of the war, were numerically superior to those of her enemies but which, as time went on, were inferior technically to the rapidly modified British designs); and, second, her airplanes were designed essentially for ground cooperation, and were considered by Germans themselves as primarily offensive weapons. Hence, they were weak in defense operations against enemy aircraft.

Thus, totalitarian direction produced basic errors in policy that resulted in products which proved inferior in over-all competition to the planes made under the relatively free enterprise system between competitive makers in Britain and, later, in America. Superiority is not a static thing—it is a dynamic thing.

In Britain, active steps toward rearmament in the air began in 1938, the government laying down a very sound approach to overall British production, with dispersal of manufacturing units and with competitive engineering designs. In this atmosphere the now-indispensable de Haviland *Mosquito* was developed by a private aircraft firm, independent of the direction of the Ministry of Aircraft Production.

MR. WARD CONTENDS THAT—

1. **Present development contracts should not be terminated.**
2. **Military research, design, and development should be continued on a constructive basis through competitive private industry.**
3. **A production program for the aircraft industry should be maintained to retain its ability to establish production processes and to permit the air forces to become familiar with the handling of such planes. This would assume that 20 percent of the number of airplanes in the air forces will be replaced annually. That would give the industry, if it knew the size of the postwar air force, a basis for planning.**
4. **New and advanced models of all types of military aircraft required for a balanced air force should be developed. And quality of the product should be the primary factor in placing orders.**

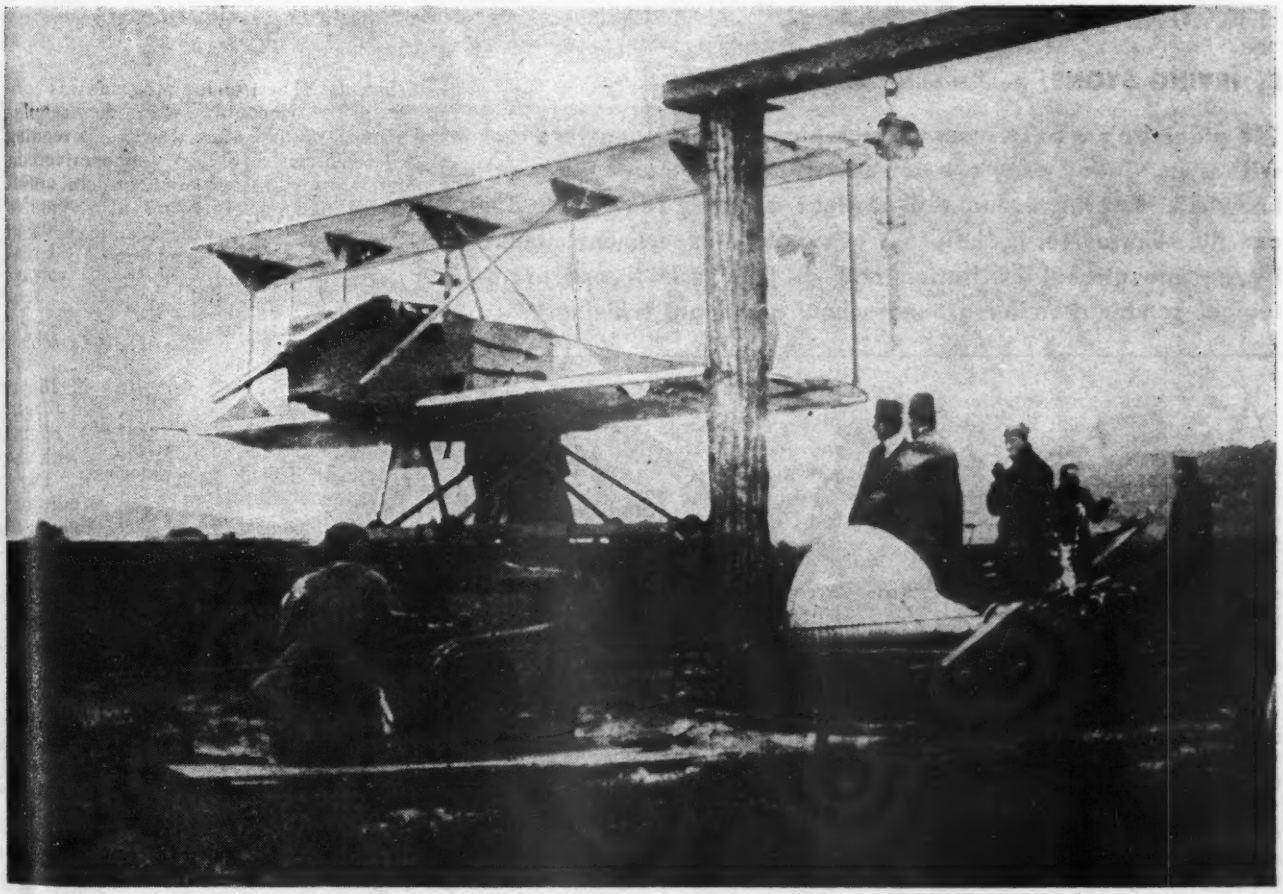
Even more important, when Britain had to meet the threat of German bombing she was ready with radar, developed in secret, which permitted 700 British fighters to stave off attacks by as many as 2,400 enemy aircraft instead of being wiped out on the ground as had already been the fate of the warcraft of France, Poland, and of Germany's other enemies.

The radar locators, plus the efficient British fighter designs and their superior armament, took such a heavy toll of the Luftwaffe that it became an uneconomical form of war and was abandoned. This happened in spite of the high prediction Germany had made of subduing England from the air, thus hoping to avoid the risks of sea-borne invasion for which she had not equipped her Navy. By having in use at that critical time the fruits of engineering development, Britain saved herself and perhaps the world from Nazi domination.

And what of America? With all of these lessons before us, we had allowed ourselves to live on a starvation diet for development, even relative to the appropriations for development of such a second rate power as Italy. The latter's appropriations for the city of Guidonia, an entire city founded for the development of aircraft, was something on the order of two and a half times our equivalent appro-

(Turn to page 251)

World's first flying bomb, launched at Bellport, L. I., in 1918 by U. S. Navy and Sperry Corp. In a test, this winged missile carried 1,000 lb. of TNT 400 mi. Yet, because of inadequate research and development appropriations, "it was left to the Germans, a quarter of a century later, to put this weapon into their own concept of total war."



Billy Sewell, 14-yr.-young "infant" of high school group, participated in Pennsylvania State Teachers College aviation laboratory program by traveling from Maine to satisfy his obsession to fly. And he came through course with highest rating in flight phase. Shown just before takeoff in "Fleet," young Sewell is briefed by Andrew Boyajian, Aircraft Services Consolidated's chief flight instructor. Sewell's dad is in Merchant Marine. Boy's aim is to be aircraft design engineer.

. . . And a Child Shall Fly Them

By IRVING STONE, *Assistant Editor, "Aviation"*

The plane isn't a contrivance which high school youngsters look at with awe. Today, they are not only ready to receive aeronautical knowledge but the manual skill of flight, as well. That young people can fly, even at 14, is the proof of a unique experiment conducted by an educational institution and a flight school operator — a logical combination for ground school and flight training.

A SUCCESSFUL AND NOVEL experiment just completed at Bloomsburg, Pa., points the way to a potentially broad field of flight school operator activity in conjunction with an educational trend in aeronautics which indicates nationwide recognition.

The experiment—an aviation laboratory summer school—is significant in that it proved the ability of high school students, as young as 14, to absorb flight instruction in addition to academic ground school training. Conducting the program was the operator-educator combination of Aircraft Services Consolidated and the 105-yr.-old Pennsylvania State Teachers College.

Activities of the former, an experienced flight organization, were under the supervision of Howard Ailor, founder of the Ailor Fly-Ur-Self System. And training by the college was under the guidance of Harvey A. Andruss, president, and John C. Koch, director of aviation education.

From 1942 to 1944 the two facilities had jointly conducted a WTS program at Bloomsburg, training over 1,000 army and navy pilots and naval flight instructors. Accordingly, at the cessation of this activity in July, 1944, the two organizations were admirably fitted by experience and cooperation to test the aptitudes of teenage students for flight and ground school instruction, and also to set a pattern for the inclusion of similar training in secondary school curriculum.

Thirteen students were enrolled in the first class of the four-week summer program. Eleven of these were boys and girls ranging from 14 to 16 yr. of age; the other two, 18 and 21, were college students. The training program was conducted concurrently with the regular summer course for teachers attending State Teachers College to obtain credit for licenses to teach preflight aeronautics in the high schools. Basic instruction in the two courses was identical, except that the teachers received additional instruction concerned with presentation of subject matter. In the second class, 12 of the 23 participants enrolled were high school students.

Flight instruction, consisting of 10 hr. of primary training in dual-control *Fleets*, was started on the second day of the course, following familiarization with the details of airplane preflight check. Daily flying time varied from 30 to 45 min. per student, coupled with an equal amount of time for review of maneuvers performed. Ratio of students to instructors was four to one, and while one student was aloft with the instructor, the other students were occupied in the day room with ground school problems.

Ground school consisted of 72 hr. of combined instruction in avigation, meteorology, civil air regulations, engines and theory of flight. In some instances, teachers attending the regular summer session of the college to obtain credit towards preflight licenses, gave this instruction to the students under the supervision of the regular instructors.

The youngest student was a boy of 14 just due to enter high school. His enthusiasm was such that he rode a bus for 36 hrs. all the way from Maine to satisfy an obsession to fly. It is significant that he received the highest flight rating, together with consistently good results in other subjects.

By comparison, the boys and girls achieved fairly equal results. In general, the grades indicate a capability to absorb this type of instruction; they compared favorably with those attained by teachers in attendance—and in some instances bettered them. Final grades are shown in the accompanying tabulation.

At the completion of the training for the first class, a written examination for private pilot's license was given the youngsters through the cooperation of CAA. Purpose of this examination was to help determine whether the curriculum was adequate in scope and time allocation, also whether ground school equipment had been properly selected and utilized to parallel the introduction to flight.

The grades attained on the CAA examination (also given in our tabulation) are generally favorable. The largest number of failing grades was in meteorology, probably because more basic knowledge was required than was possessed by some of these youngsters at their stage of education. Using the performance of army and navy students who trained at Bloomsburg as a basis for comparison, supervisory personnel felt that the youngsters generally possessed greater enthusiasm and that they more readily mastered basic flying techniques.

The reasons underlying the desire of these teen-age boys and girls, from many localities, to learn to fly indicate relationships to their expected future interests. It is likely that these reasons are representative of high school student interest throughout the country. An interview with the Bloomsburg students revealed activities expected to be followed, which included among others, aeronautical design engineering, mining engineering, air freight transport, mechanical servicing, development work in South America, and the medical profession. All felt that flying would be an essential adjunct to their work, and aside from future utilization in connection with business, they considered flying a most pleasant recreation.

Close on the termination of the first class at Bloomsburg, an aviation conference, sponsored by the State Department of Public Instruction of Pennsylvania was held at Harrisburg, attended by representatives of CAA and the State Aeronautics Commission, high school principals and teachers, superintendents of schools, flight operators, and representatives of colleges interested in aviation

(*Turn to page 279*)

RECORD OF THE FIRST CLASS[1]

Students	Age	Subject								
		Avigation		Engines & Theory of Flight		Meteorology		Civil Air Regulations		Flight
		School	CAA Exam	School	CAA Exam	School	CAA Exam	School	CAA Exam	
Boy	16	90	87	90	73	90	60	80	87	78
Boy	16	65	80	80	70	90	63	80	87	80
Boy	15	73	73	93	77	88	70	80	87	80
Boy	15	40	43	50	37	70	37	75	67	78
Boy	14	70	77	80	83	85	67	80	73	88
Boy	16	70	87	84	73	75	57	80	87	78
Boy	16	79	80	85	57	85	73	80	87	82
Girl	16	83	83	80	73	90	67	85	90	80
Girl	14	70	60	68	53	90	50	80	60	78
Girl	15	83	70	70	43	80	53	85	80	82
Girl	16	80	67	60	60	75	63	80	90	70
Girl	18	90	——	83	——	85	——	90	——	78
Girl	21	93	——	90	——	85	——	90	——	80
Teachers[2]										
1		88	90	77	——	95	73	85	93	65
2		74	60	65	80	90	67	80	83	
3		85	83	90	70	——	——	——	——	
4		98	83	99	77	——	——	——	——	
5		93	90	91	93	——	——	——	——	80
6		——	77	——	57	100	87	——	93	70

[1] 70 is passing
[2] Subjects optional

Capabilities of the youngsters are evidenced in the breakdown of grades. Note comparative performances of the teachers.

Shown here in group comprising first class of State Teachers College aviation laboratory are 11 youngsters ranging from 14 to 16 yr. of age, who conclusively demonstrated ability to fly. Uniformed men in background are John Koch (left), director of aviation of college, and Asher Wolfe (right), faculty member. Two teachers who attended summer class stand left and right of center.

MAKING THE AIRPORT A BUSINESS CENTER

By **MELVIN H. NUSS,** *Secretary, Municipal Airport Commission, and Manager, Municipal Airport, Reading, Pa.*

Far-sighted planning and cooperation between city and county make flying facilities integral with community industrial life.

PLANNING the airport at Reading, Pa. began long before the physical project was started, the entire plan being based on the idea that a successful airport must be part of the business life of the community it serves.

In the preliminary work was included a survey of the transport and shipping needs of Berks County and immediate area and the whole project was based upon the figures thus obtained. By these means the need for an airport was definitely established before the actual plans were started.

Reading was one of the first communities to approach airport planning on this sound basis; since then several others have also followed suit. The example is one which could well be followed by every group of business men desirous of developing outstanding aviation facilities.

The original field, built as a WPA project, was dedicated in October, 1939. At that time it had the conventional two runways of a CAA Class 2 airfield and no more apparent future than that which could be developed by any fixed-base operator who might think it a desirable location.

When the AAF took over in '42, need for a prosperous local airport was recognized by a farseeing mayor and a progressive city council. An airport commission was appointed by the Mayor and Council in May, 1937, and necessary funds guaranteed. Also, the original short runways were improved and lengthened and Reading shortly entered the group of airline cities when TWA made the airport a regular stop on its route to New York and the West.

It was when the AAF acquired the field (as a support base for Mitchel Field) that the government offered to extend runways and build others, if the city council would add sufficient land. This was done, the contract calling for return of the airport to the city six months after the termination of hostilities. By that time the field will have four runways, each over a mile in length and will be capable of handling any probable expansion of traffic, regardless of future increases in airplane size or weight.

To support successfully a field of this type, a year-round flow of business is required, both coming and going. Working in conjunction with the Airport Commission, the Mayor and Council decided that the nearly 800 local industries and a prosperous farming community with a primary territory of service wherein 300,000 people reside and work, would be able to provide the business, if the airport itself had the the required facilities and connections.

Melvin H. Nuss, leader in development and future planning of Reading Airport.

A postwar program was developed which would eventually call for an expenditure of over $1,000,000, half of which was immediately guaranteed by the city. The Board of County Commissioners, which in the past has assisted generously financially, indicates its further support. This was estimated to be necessary for buildings and other facilities for an up-to-date airport.

The general plan was that an airport, to be successful, must not be merely a passing point through which passengers will come and go, but an integral part of the business life of the community. To this end it is planned to provide, first of all, the usual airline offices and maintenance shops, better than usual accommodations for passengers and entirely separate spaces for the sightseeing public. Then, following the example of the larger railroad terminals, the usual stores, catering to travellers, would be provided, together with banking facilities and possibly a theater. Ample parking space and a service garage are included in the plan.

Freight and air express are to be separate entities, with loading platforms for trucks and belt conveyors for economical handling of packages. Estimates have already been made for pneumatic delivery of mail to and from the city post office, thus removing the delivery time factor, hitherto the greatest obstacle to speedy airmail service.

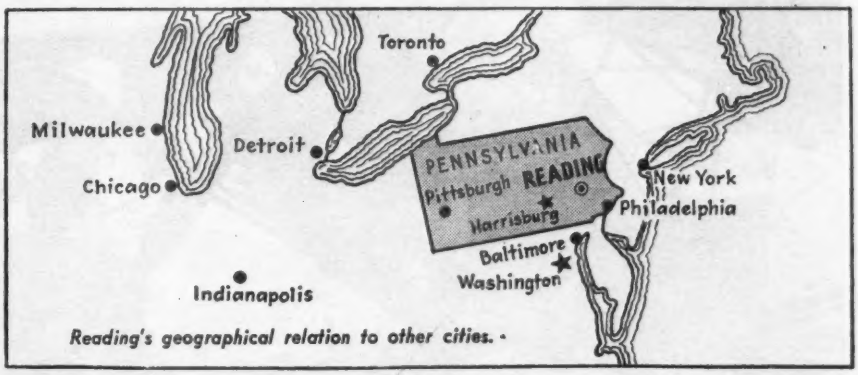
To make the airport part of the life of the non-flying public and to render them air-travel conscious, a produce market is planned as part of the general layout. Here, delivered by air within a few hours from their places of origin, will be sold Maine lobsters, Columbia River salmon, Texas early strawberries, tropical fruits, Florida swordfish and out-of-season vegetables and fruits now difficult to obtain, owing to transportation delays. Wholesalers will distribute promptly the produce to the corner shop keeper within the trade area, bringing to the housewife

who does not desire to shop at the airport retail market, the same luxuries. Local grown produce, eggs and poultry will in turn be shipped to other markets heretofore unavailable to the local producer.

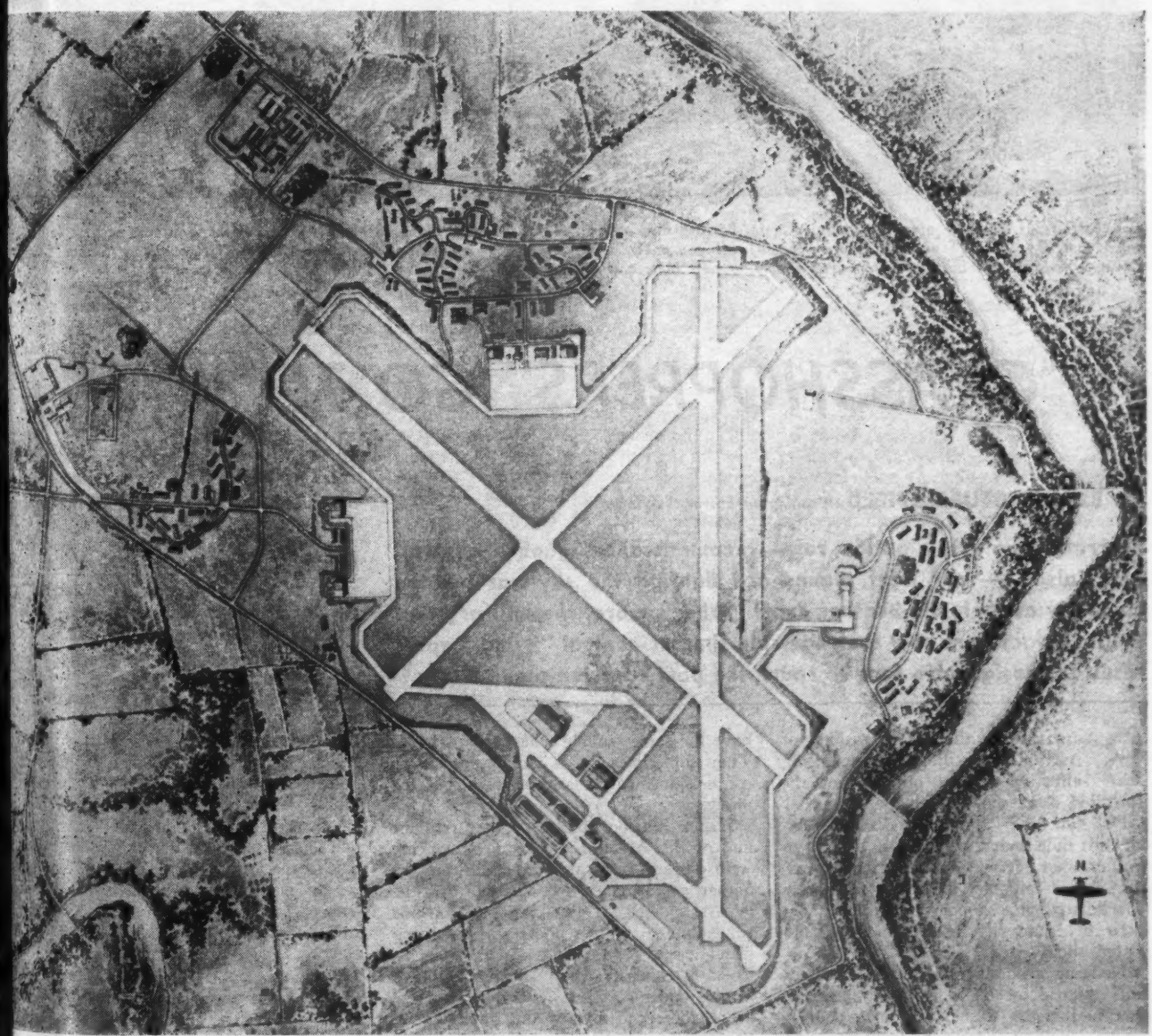
To integrate the picture of a complete commercial center, instead of a "jumping off place," arrangements have been made for leasing store space to local businesses. As the airport is not more than 15 minutes drive from the middle of the city, it is to be expected that many shoppers will find this new business center with its free parking space a pleasant and convenient place for transacting their daily purchases.

For the benefit of those who will learn to fly, arrangements have been made for flying schools, and low-rental hangars will be built for privately owned planes. Travellers by bus will find a commodious bus terminal, enabling non-air travellers to use their chosen method of transportation while enjoying all the other facilities of the airport. Plans have been discussed with a prominent airline specializing in pickup service, for an intensive local system as a feeder.

Summing up, this city and the county in which it is located have come to the conclusion that an expenditure of several dollars per person in the entire county will be both advantageous and profitable, but that to make the investment safe and permanent, the airport must be a part of the business life of the entire community and not merely a flat place where one boards or leaves an airplane.



Reading's geographical relation to other cities.



Reading Airport, situated in bend of the Schuylkill River, is on a flat tableland 15 min. from city center. N-S runway is 5,000 ft. long, two others 4,550 ft. New E-W proposed runway will be 4,800 ft. long. Present Army buildings (bottom) will be removed and imposing central administration offices erected in their place. Banks around outside of airport will be planted with flowers.

For battlefront business of super-snooping (we borrow term from this Piper L-4 "Cub's" very descriptive name) all you need is a farmer's field within buzzing distance of enemy, a pup tent, and a "grasshopper" plane. Seen here is Lt. Perkins, graduate of first "class," North Africa School for Liaison Pilots. (U. S. Army Signal Corps photo.)

"GRASSHOPPERS" GO TO WAR

By BLAINE STUBBLEFIELD, *Washington Editor, "Aviation"*

Starring in a triple-action role—reconnaissance, gunfire control, and liaison — our light planes are fighting the sky-war just as certainly as their big-brother craft. What's more, the military and the manufacturers now seek non-spin simpler-control "flying jeeps;" resultant designs are sure to spark the postwar civil-plane market.

BEGINNING with the invasion of Africa, the Artillery has been using effectively large numbers of the so-called "grasshopper" planes as "Air OP's" (air observation posts). The 800-lb. aircraft hide under trees, fly up and down gullies, spot enemy works and concentrations, radio pinpoint locations from their coordinated maps, correct salvos from their field batteries, call "fire for effect" —and then scram.

Dodging groundfire and enemy fighters and natural obstructions, scanning the terrain for gun flashes and troop movements, making precision locations and transmitting information—all this leaves the two-man crew little time to attend to the fine art of flying. The Artillery pilots have the same trouble that civilians have: They sometimes cut it too fine and drop off in spins. Not many of them, but too many.

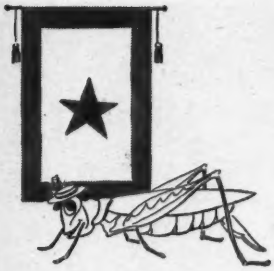
Hence Liaison officers of the Artillery and of the Air Forces are now working with several aircraft manufacturers on higher performance specifications for the "grasshopper." If the war goes on for some time, Air OP's pilots will be sitting safer in spin-proof planes—sitting, that is, as safe as anyone can sit between two armies and under two air forces. In any event, the trend toward simplified-control non-spinning light plane designs augurs well for the postwar civilian market.

At present, however, the Artillery does not favor two-control design, maintaining that it wouldn't give the needed maximum maneuverability.

It was in Nov. 1942 that three Piper *Cubs* flew off the deck of the USS carrier *Ranger,* 40 mi. at sea, and landed in Africa. In error, a cruiser, several destroyers, and troop ships of the United States Navy fired on them, happily without effect. Then when they arrived over land, American ground forces cut loose at them. Capt. Alcorn was shot down and was returned to his home with injuries. Lt. Snell was brought down by machine gun fire, uninjured. He send word ahead to his destination, once more took off—and was fired on again. He reached the field, however, but a major who had come out to meet him mistook his flying jeep for an enemy craft and gave him a blast from a tommy gun. No hits. The third ship, carrying Lt. Butler, with Capt. Devol as passenger, arrived safely.

This was the bad beginning of what was to become a very successful enterprise: Light plane fire control and reconnaissance for the Ground Forces.

One interesting liaison plane operation was the conversion of LST (landing ship, tank) boats into *Cub* aircraft carriers. A

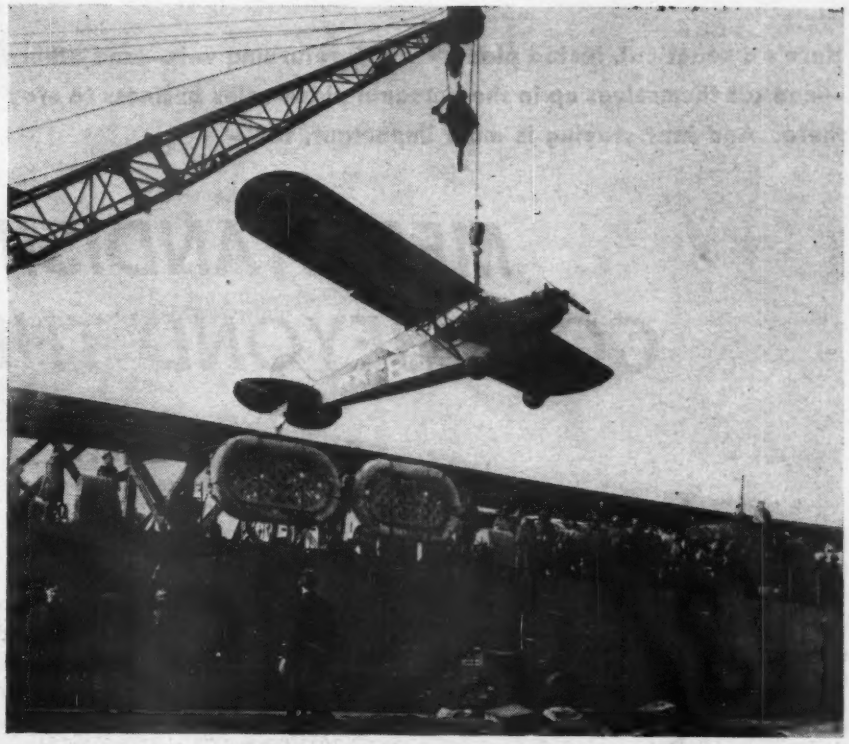


flight deck approximately 70-yd. long and 12-ft. wide was designed and built by the Engineers. The framework was mainly of 4-in.-by-6-in. timbers, and the floor was regular steel runway matting. By trimming the ship with ballast in the forward tanks, the runway was given a slight down-hill tilt.

The takeoff started with braked wheels and high tail, so the pilot could see the white guide line painted on the strip, and the plane was held down on its wheels till the very end was reached. When the wind was at 10 mph. plus 9 knots of ship headway (making roughly a 20-mph. headwind) the airplane attained flying speed in three-quarters of the runway. Eight planes were shipped on this carrier, two on the flight deck, two on the main deck, and four disassembled. These planes went ahead of beaching operations, and in some cases landed with valuable information for parties that had already gone ashore.

In Sicily, landing strips were few, uneven terrain caused serious turbulence, and liasion pilots learned to fly out to sea beyond range of gunfire, parallel the coast, and look up the valleys at what the enemy was doing. If caught over the water by attacking enemy fighter planes, the L-4's were in a bad way. But they always managed to get over land, where natural obstacles helped them to evade speedier craft.

The Germans, attacking liaison planes in Sicily and Italy, always came in groups, using Me-109's, FW-190's, and sometimes Ju-87's and He-111's. Only once, according to the Artillery Association, was a *Cub* jumped by a single enemy plane.



Unique was conversion of some LST boats into "grasshopper"-plane aircraft carriers. This one, snapped at dock in Italy, takes "Cub" aboard via hoist. Note narrow flight deck; measuring about 70-yd. long and a mere 12-ft. wide, it's framed of 4"-by-6" planks and is capped with regular steel runway matting. In action, L-4's fly in from LST-carriers to spot enemy defenses just prior to beaching operations, and in some instances these planes land with information for parties already ashore.

The War Department press service tells of a certain Nazi heavy gun that kept up a slow but steady fire from behind a ridge despite all the fire concentrated in the valley. A grasshopper went up and scouted the terrain corridor. It spotted a big gun being run in and out of a tunnel, on tracks. The liaison pilot radioed exact coordinates locating the gun, and a gun in each of three American battalions made leisurely precision adjustments on it. After pausing a half hour, the Germans decided things were right for more shooting, so they rolled out their piece and fired another round. Quickly, a three-battalion concentration demolished the German gun.

One day in North Africa, Air OP's got a report that German tanks were concentrating in a village over a hill. The American general wanted to see the tanks for himself, so he himself went aloft in a

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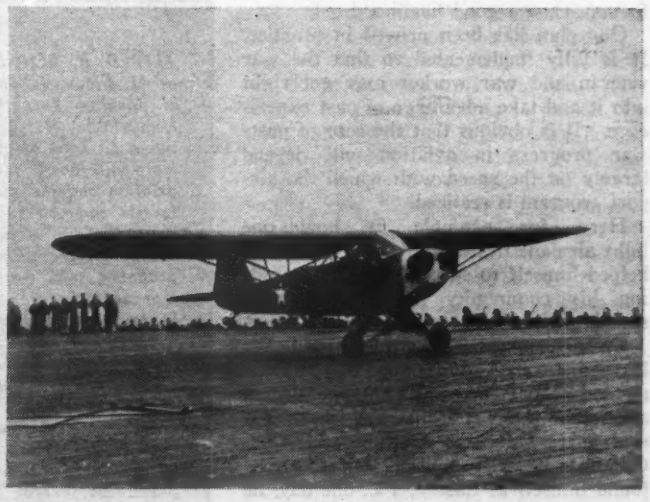


To inaugurate fight-plane fire control and reconnaissance work, three L-4 "Cubs" hopped in November 1942 from Carrier "Ranger," 40 mi. at sea, and landed in North Africa. Unfortunately, two of ships were mistaken for enemy craft and shot up by our own forces, as recounted in this article. The third, piloted by Lt. Butler and carrying Capt. Devol as passenger, came through unscathed. Here (left) Officers Butler and Devol prepare for takeoff from "Ranger." Right: Tail up, they're on their way. (U. S. Navy photos.)

Here's a practical, tested plan by which returning vets—and others —can set themselves up in the personal plane sales business to stay there. And that staying is most important, for—

MERCHANDISING GOES BEYOND THE SALE

By ALFRED B. BENNETT
Director of Sales, Aeronca Aircraft Corp.

POST-WAR EMPLOYMENT PLANS and the weather too often seem to share Mark Twain's words on the latter that "everyone talks about it, but no one does anything."

We cannot do anything about the weather, but we are doing something practical in providing the means for gainful employment and advancement of returning war veterans and others. We have, not tomorrow but today, the first comprehensive plan for helping both men and women utilize their war training so that they may return smoothly to civilian life by developing their own businesses to the limit of their ability in the typical American way.

Aeronca has made personal planes for 16 yr. After fulfilling war contracts, it intends to continue making them. But the company does not feel that its job ends there. We of the organization feel that aviation has a responsibility to the public. We have no desire merely to sell airplanes. We have, instead, the conviction that with young Americans willing to fight overseas, we at home should have an effective plan ready and working for them so that the disabled as well as the fit may earn a good livelihood.

Our plan has been proved in practice. It is fully implemented so that the war veteran and war worker may get right into it and take advantage of past experience. It is obvious that the rate of post-war progress in aviation will depend largely on the speed with which the airport program is realized.

Here, for example, is how one light airplane dealer and airport operator helped himself to success, as well as aiding his community by establishing a sound, paying business:

Cy Rich started as an airplane mechanic, learned to fly, and studied a practical method of airplane sales and airport operation that the writer had instituted several years before at Hightstown, N. J. Cy did not lack ambition, but when he found himself at Easton, Pa., one day, he only had $12 to his name.

He promptly borrowed an old plane from a friend and began operating out of the old Easton airport. Business improved. He soon found a better field, closer to the main flow of traffic and nearer the business life of the community. He leased this field for $33 a month and soon was making more than enough to pay for it.

That was in November 1939. By January of 1943 he had 73 airplanes based on the field. He had bought a $1,000 portable hangar on credit, paying it off at the rate of $20 a month. He soon financied six more hangars through a bank. He found that by going out and getting business in the manner already proved practical at Hightstown, he could pay off his hangar costs, buy more airplanes, hire additional pilots to help train students, and operate a repair shop.

ALFRED B. BENNETT, better known as Al, discovered during the first years of running Bennett Air Service at Hightstown, N. J., that every light plane he sold created a demand for more airplanes. He also found that aviation and the public had many interests common to both. By putting these facts to work and by applying sound merchandising principles, he probably sold more personal planes than any other man. At the same time, he taught more than 3,000 people to fly. Today, with Aeronca, he has evolved a comprehensive plan based on practical experience for rehabilitating war veterans and helping readjust war workers with or without any previous training in aviation. The accompanying article details Bennett's plan, with several "case histories" to illustrate the practical application of the author's ideas.

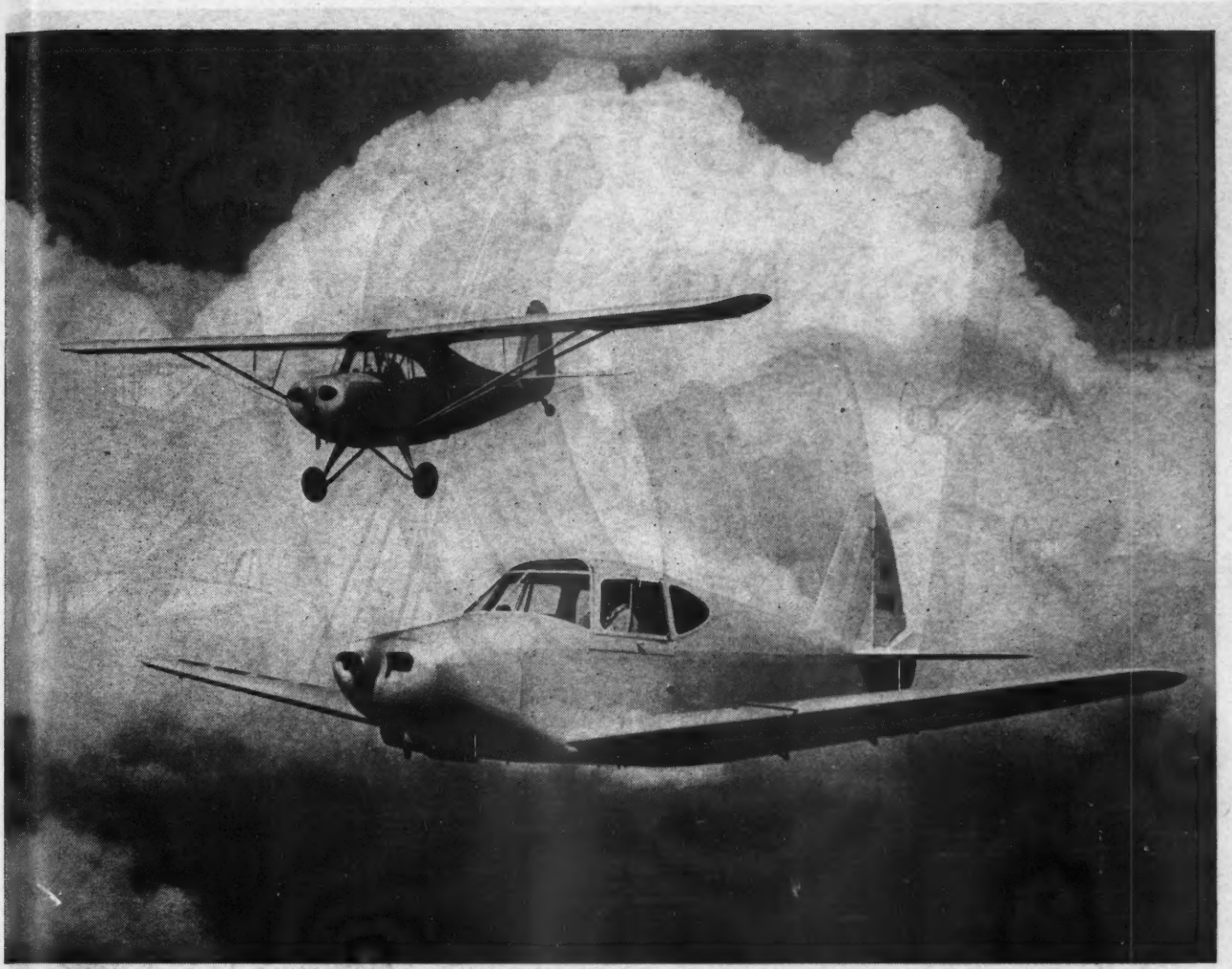
Cy Rich at his peak was taking in $200 a month from rental of 12 hangars, fees from staking 35 ships outside, selling airplanes (he sold 33 in his first year of business), instructing, doing aerophotography, and making repairs. The war necessitated curtailing his civil activities, but he proved to himself and his community that a well-organized, practical plan can pay off.

How do we help others to do as well as Cy Rich did? With a handbook now in preparation called *How to Make Small Airports Pay*, we are showing a man how and where to locate his business. It probably will be in his home town. Or if there may be a better prospective location, we will advise him on the desirability of the site he chooses. That place of business will be a field suitable for an airport —nothing pretentious to start with, but technically right.

We already have distributors in every state and in Canada. These are being steadily augmented. They will help potential dealers determine the value of the land intended for the airport and will advise how best to acquire it. They will check on existing airports and other potential ones. They will point out the importance of traffic flow, study the trade area and the characteristics of the community—in short, they will give the prospect the result of all our experience and training in a procedure that has been proved practical.

If there is no distributor close to some particular point just yet, personnel from our Middletown, Ohio, plant will make a survey in his place. Drainage, elevation, boundary obstacles, and other important factors, will be studied, conclusions drawn, and definite advice offered.

We think there should be no limit to the



Two Aeronca entries in tomorrow's light plane field. High wing two-place tandem job (top) designed for flight instruction and general utility flying, such as that connected with farming, mining and prospecting. Twin sister to this craft will have side by side two passenger arrangement, but with many parts interchangeable to simplify production, maintenance and reduce inventories. Also undergoing flight test is low wing all metal craft with retractable landing gear (below). (Hans Groenhoeff photo)

number of dealers within the distributor's territory. Anyone who can meet our standards should be eligible for an Aeronca airplane sales franchise. Contrary to some beliefs, this practice will not slice the cake that much thinner for existing dealers. On the contrary, it will help everyone make more money by making more sales—because more people will be flying and facilities for flying will be improved as a result of the newcomer's efforts. We are assigning personnel to compromise any difficulties that may arise, with steady liaison maintained with the home office and plant.

That dealers can, with help, develop a highly successful business based on a small, carefully selected airport is proved again by the following case history:

Gordon Cahill was still in his teens when he learned to fly from the proceeds of his job as a truck driver. Saving his scant funds, he and a partner bought an old, cracked-up plane with which to build flying time. Cahill stuck to driving his truck and, by continued careful saving, was soon able to buy his first modern light plane.

He journeyed from South Jersey to the Hightstown airport, which I was operating, and made careful notes of our steady progress in instructing, hopping passengers, hangar rental, and airplane sales. It wasn't long before he decided to establish an airport of his own. I was glad to help because more airplane distributors and airports meant over-increasing interest in flying.

Cahill found a small field fairly near Bridgeport, N. J., and he soon had four students. A new and larger field was soon required as business expanded. He finally located a 73-acre tract of farm land. It was much better situated than his old field, being on a principal highway only half-a mile from Bridgeport. Cahill paid $25 a month for the entire tract, with house, barns, and chicken houses thrown in. He tore down the barns, and their lumber provided material for two T-hangars.

His first flying club was formed when 10 persons put up $50 each to buy a one-tenth share in a light plane. Monthly payments of $10 each for one year paid off the balance on the ship, and members flew at a cost under $2 per hour. This chance to build up flying time at a reasonable cost soon attracted other students and additional clubs were formed. Every new club helped to form another.

On all flights, Cahill demonstrated how easily the light planes handled. It wasn't long before the whole countryside was talking about the constantly expanding clubs, the ease of flying, the fun of taking hops, the purchase of one's own plane.

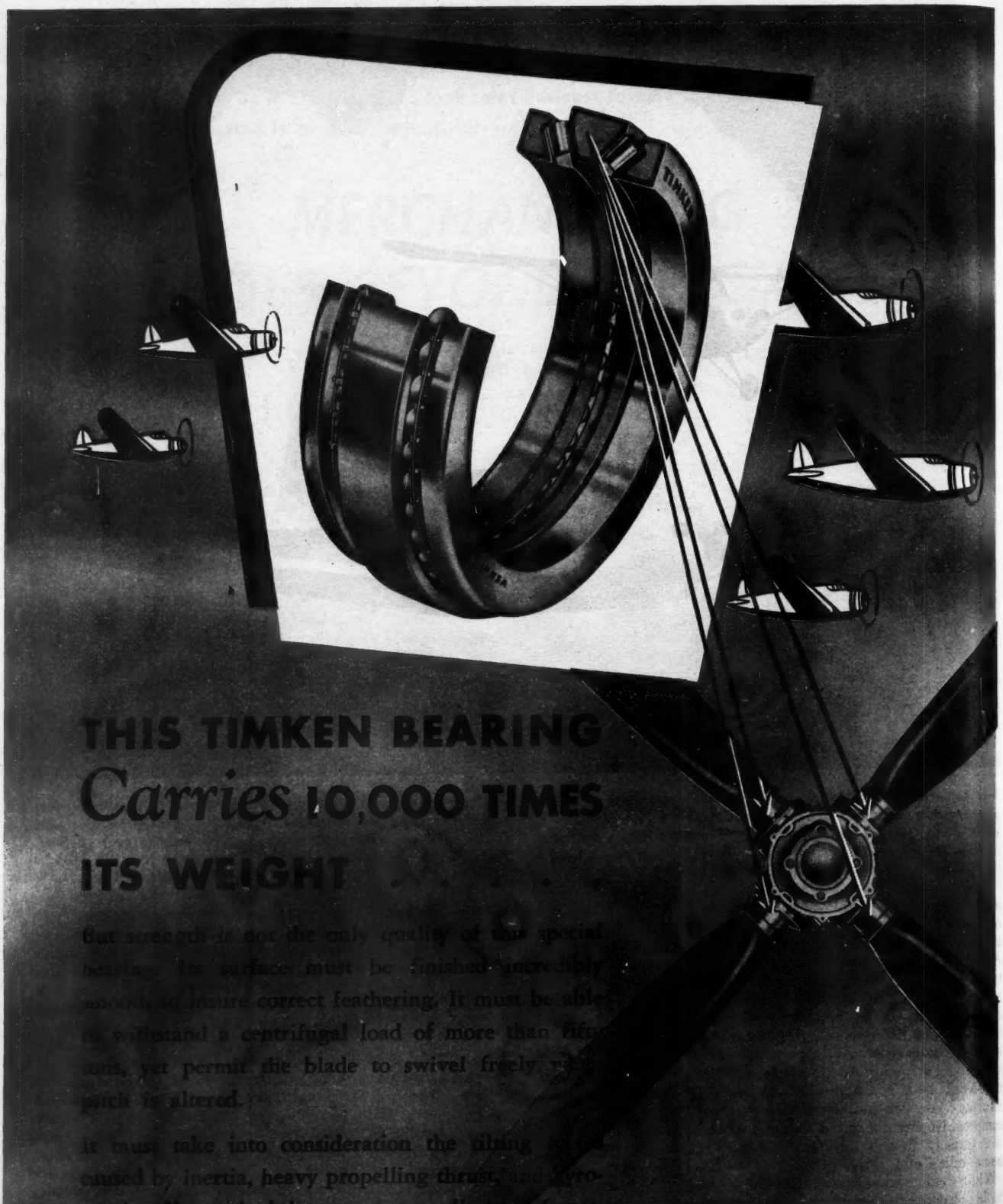
Cahill soon decided to build two more and better hangars. His first one, 170 ft. long and hangaring six light planes, was soon followed by one 212 ft. long, accommodating eight other craft. A nearby building supply dealer and Cahill's bank helped him finance the improvements, which later included two hangars each 45 ft. square which housed individual planes.

With Cahill's business steadily expanding as a result of practices proved successful at Hightstown and now incorporated into the Aeronca plan, the CAA deputized him as a special government flight examiner, which saved his students money and time in taking their tests.

More than 400 men and women soloed from Cahill's airport before the war took many of these into the armed services and postponed further civil aviation expansion until after the war.

We feel that decentralization is a major

(Turn to page 259)



THIS TIMKEN BEARING *Carries* 10,000 TIMES ITS WEIGHT

But strength is not the only quality of this special bearing. Its surface must be finished incredibly smooth to insure correct feathering. It must be able to withstand a centrifugal load of more than fifty tons, yet permit the blade to swivel freely when pitch is altered.

It must take into consideration the tilting of the plane caused by inertia, heavy propelling thrust, and gyroscopic effects. And it must carry *all* these forces, applied at long leverage, by a few rollers on opposite sides of a base with only a 6¾" span.

If you have a propeller feathering problem, we'll be glad to help solve it. Don't hesitate to consult us. The Timken Roller Bearing Company, Canton 6, Ohio.

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TAPERED ROLLER BEARINGS

AVIATION

Presents a New Regular Feature

FOR *Better Design*

• STILL LEADING THE FIELD, AVIATION this month inaugurates a new department, comprised of clear concise text and illustrations of practical ideas, methods, and materials that will help America's aeronautical industry continue to design and build the world's finest aircraft.

These Better Design features will be gathered from every phase of the industry in every part of the world.

Some will come from service and maintenance men in combat zones—they will help service and maintenance men in other war theaters keep more planes aloft longer. Some will originate on aircraft production lines—they will help other production lines turn out better planes faster. Some will spring from engineering departments—providing the answers for other such departments facing the same or similar problems. Some will come from experimental units—to help other researchers in matters of aerodynamics, materials, production, operation and maintenance.

These Better Design features will be presented *in addition to* AVIATION's other regulars, and should provide an unusual complement, especially to the Design Analyses and Sketch Book of Design Detail. They will make a ready reference, always-up-to-date handbook written for one purpose—to create better airplanes.

TRANSPARENT SECTIONS SIMPLIFIED

IMPROVED field service in addition to facilitated production resulted from redesign which simplified escape hatch and window construction in the pilot house of the Martin PBM *Mariner*.

The new pilot's escape hatch (Fig. 1), hinged for easy outward opening in emergency during flight, is essentially gadget-free and typifies a "design by subtraction," eliminating by its simple all-welded construction various levers, links, bellcranks, castings, formed parts, bolts, screws, and rivets of the original hatch design (Figs. 2 and 3).

The new unit, requiring but one and one-half hours to install, is more easily held to the plane's contour, is sealable, and can be positively locked in the open or closed position. The old hatch sometimes failed to hold its shape against the double contour of the plane nose, and did not give a perfect seal even though it had been "beefed up" from a normally light frame to improve sealing qualities.

Glazing feature of the new hatch, the moulded rubber Hunter-Sash (Fig. 4) which precludes Plexiglas breakage and

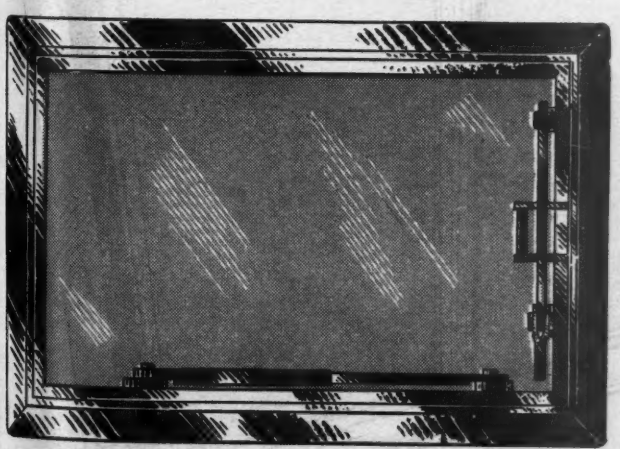


Fig. 1. New pilot's escape hatch on Martin PBM Mariner typifies clean and efficient design of all-welded construction. Hatch has no complex mechanisms, is easily held to plane's contour, and is readily sealable.

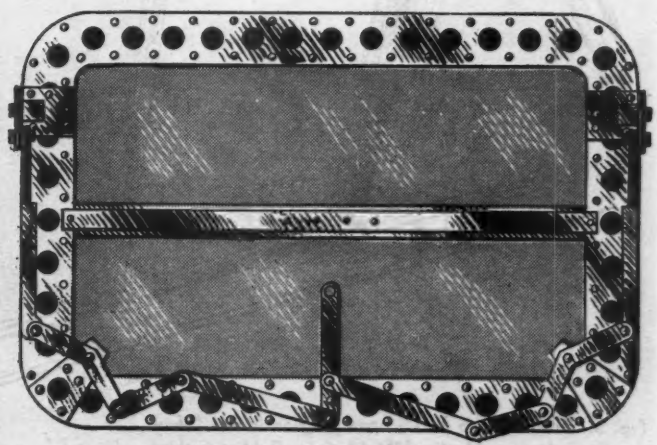


Fig. 2. Original hatch of comparatively complex design embodying many parts, did not give sealing characteristics achieved with new hatch.

Fig. 3. Simplicity of new escape hatch design is noted by comparison with details of original hatch shown here disassembled.

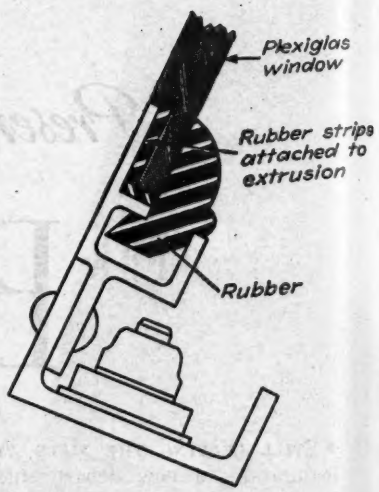


Fig. 4. New hatch incorporates Hunter-Sash as glazing feature. Sectional view shows how moulded rubber fits into retaining extrusion, precluding Plexiglas breakage, and sealing against moisture.

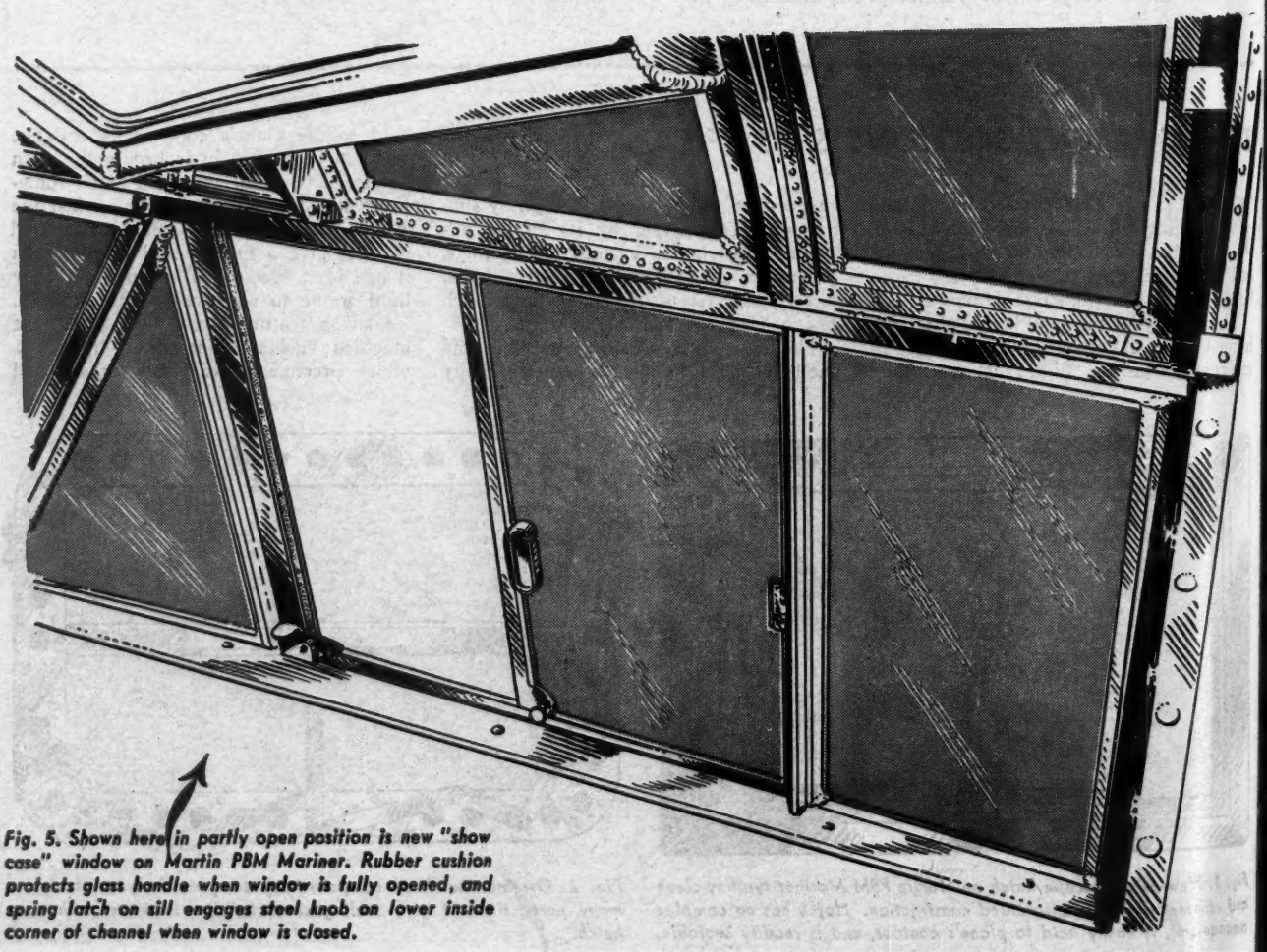


Fig. 5. Shown here in partly open position is new "show case" window on Martin PBM Mariner. Rubber cushion protects glass handle when window is fully opened, and spring latch on sill engages steel knob on lower inside corner of channel when window is closed.

seals against moisture, is fitted into the retaining extrusion in less than five minutes.

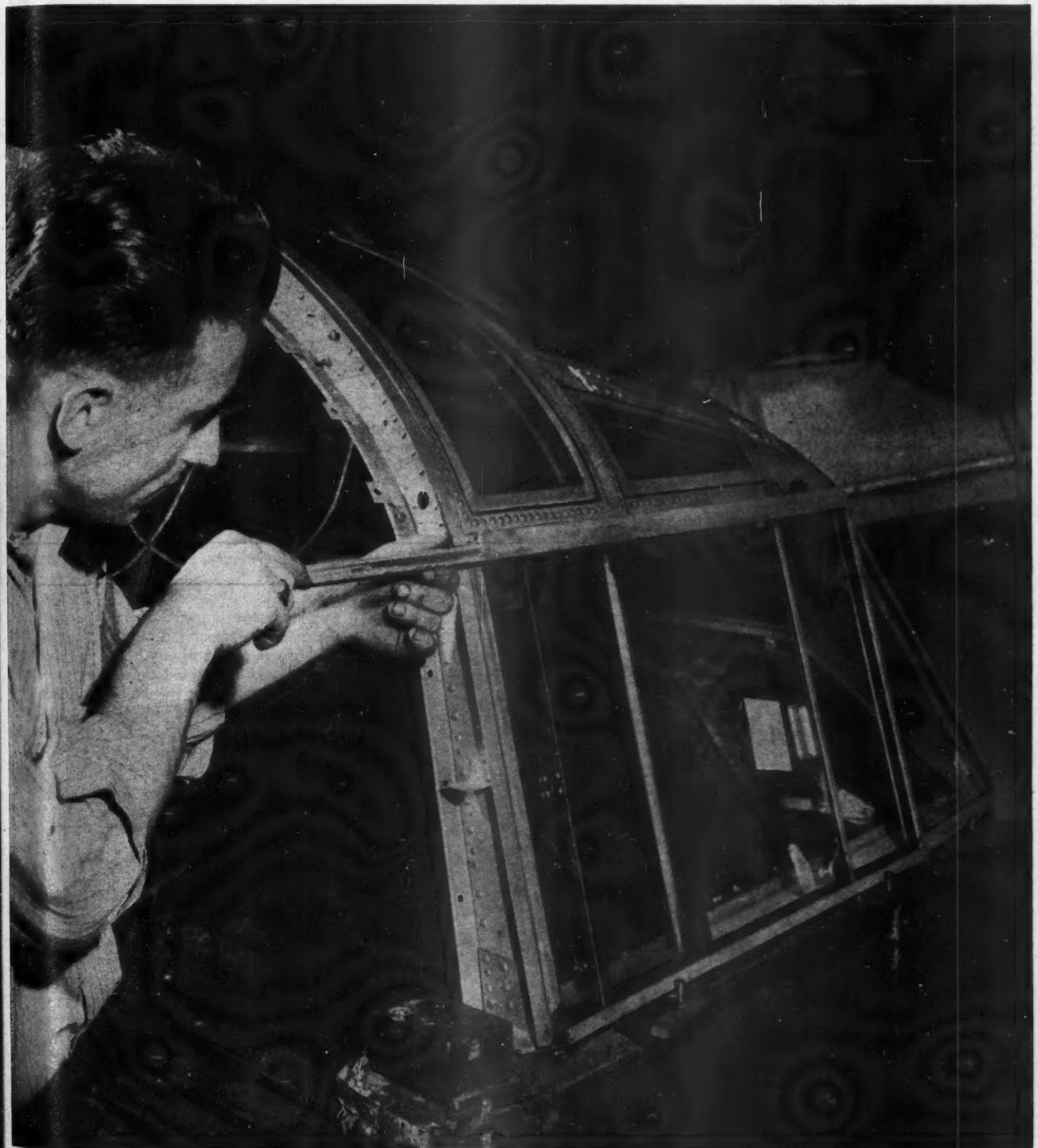
Simplification of the hatch design has resulted in considerable shop savings, and includes elimination of numerous screws and many hours of custom-built small parts assembly and adjustment to locking mechanisms.

Another item of redesign improvement in the PBM pilot house is a single waterproof window which has replaced a two-panel section of comparatively complex movement in a dual-jogged track. The new window (Fig. 5) slides back and forth with "show case" simplicity in a track consisting of two channel sections lined with Schlegel cloth, and requires a minimum number of operating and locking devices. In redesign, the window has steel channel sections clamped fore and aft, over thin layers of Everseal filler. The handle is a glass block attached by vinyl, and a steel knob welded to the lower inside corner of the forward channel snaps into a spring latch on the sill when the window is closed.

The window is installed by inserting the top first, dropping the panel into lower track, and inserting strips of phenol-fiber filler and Schlegel cloth strip between the window and the upper track channel to provide a firm seat (Fig. 6). Filler strips and Schlegel cloth are secured with countersunk bolts.

When closed and latched, the vertical channel sections of the panel fit snugly against other strips of Schlegel cloth riveted to the pilot house frame. A rubber cushion attached to the vertical sill post prevents damage to the glass handle when the window is completely opened.

Fig. 6. Application of filler strips of phenol-fiber inserted simultaneously with upper Schlegel strip and secured with countersunk bolts, provides firm installation for new Martin window consisting of single waterproof "show-case" panel.



COWL FLAP ALTERATION ELIMINATES WEAR

AN ENGINE COWL FLAP ASSEMBLY on a PAA Boeing 314 was reworked, as shown in Figs. 1 & 2, by cutting away end portions and inserting V-shaped connecting gap strips of asbestos-impregnated wire-woven 1/16 in. Neoprene sheet, to eliminate maintenance formerly necessitated by operational and vibration-chatter friction effects on overlapping ends. The connecting gusset is riveted to one flap section, and is secured by screws to the adjacent section to permit individual flap removal.

The new unit, developed by collaboration between engine shop and engineering personnel, is still under service test to definitely determine the best gap material and end connection details, but after more than 1,200 hr., the Neoprene inserts show no apparent signs of deterioration. The only change is discoloration resulting from exposure to the elements.

Before this re-design, the flap ends required replacement approximately every 600 hr., and occasionally the countersunk rivets which were used to attach a Micarta facing to the underside of the over end of the flap fell out as the surrounding facing was worn away by friction.

A coating consisting of equal parts graphite and dope applied to the contacting surfaces (Micarta removed) gave better wearing characteristics; continued departmental collaboration resulted in devising the Neoprene sheet insert.

Fig. 1 Reworked cowl flaps on Pan American Airways Boeing Clipper features adoption of wire-woven, asbestos-impregnated Neoprene sheet gap strip for connecting flap section ends, to eliminate friction caused by opening, closing and vibration of cowling. This sketch shows cowl in open position, with gap strips extended.

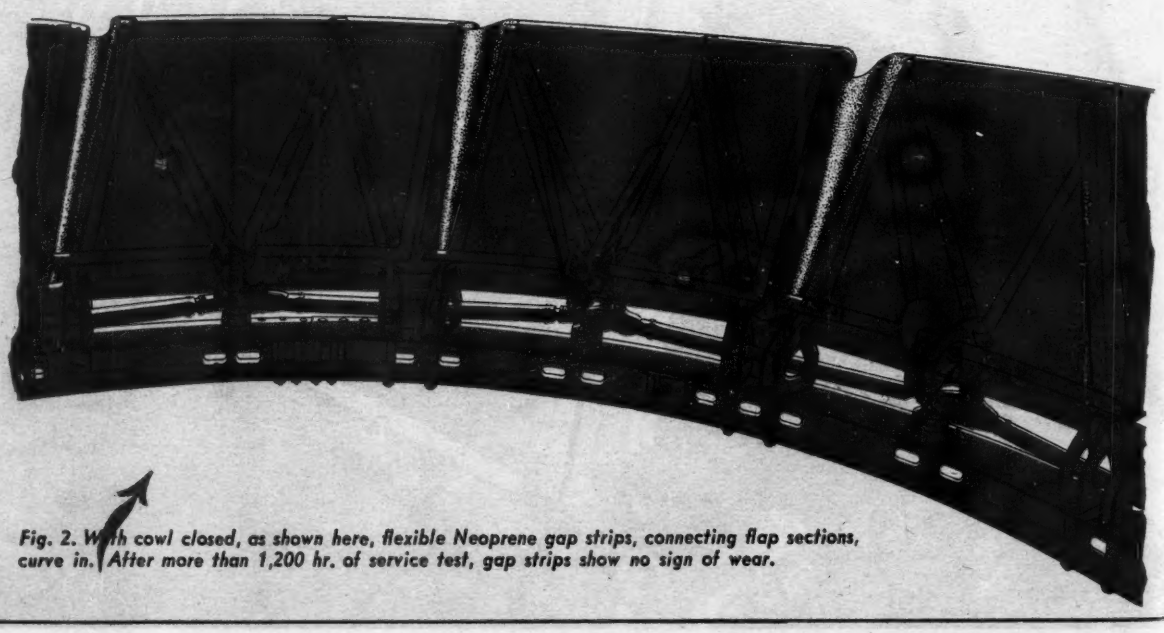


Fig. 2. With cowl closed, as shown here, flexible Neoprene gap strips, connecting flap sections, curve in. After more than 1,200 hr. of service test, gap strips show no sign of wear.

High Frequency A.C. "Ups" Motor Performance*

PART I

By J. D. MINER, *Westinghouse Electric & Mfg. Co.*

Thirty horsepower for auxiliaries is a normal but somewhat tough order for the aircraft electrical manufacturer to fill. Here, one of those who handled it tells how it is done.

INTEGRATED A.C. SYSTEMS for aircraft are new, but the use of a.c. on aircraft is by no means a novelty. High-frequency wind-driven alternators were used as long ago as 1918 to power the rotary-spark-gap radio transmitters used in World War I. And during the early 1930's, radio transmitters on Navy seaplanes were operated from wind-driven alternators and, later, from main-engine-driven alternators.

It might have been expected that with this head start, a.c. systems could have been developed many years ago. Instead, the need for battery standby power for emergency radio operation shifted attention to the development of d.c. radio apparatus. As soon as batteries became standard equipment, low-voltage d.c. was available for other purposes and electric operation of accessories became inevitable. Success of the electric starter alone could well have been enough to establish the 12-v. d.c. system as the standard power supply system for virtually all airplanes built prior to 1939.

The convenience, economy, and reliability of electrically operated devices fostered the rapid development of additional accessories and with the mounting list, power demands pyramided. Employment of two or more generators in parallel became common, and the simplicity of parallel operation with d.c. generators became a powerful argument for the use of this current. The advent of war and new combat needs stimulated the development of still more equipment until, by 1939, it was necessary to increase the power available by doubling the system voltage and standardizing on 24v. systems for all large airplanes.

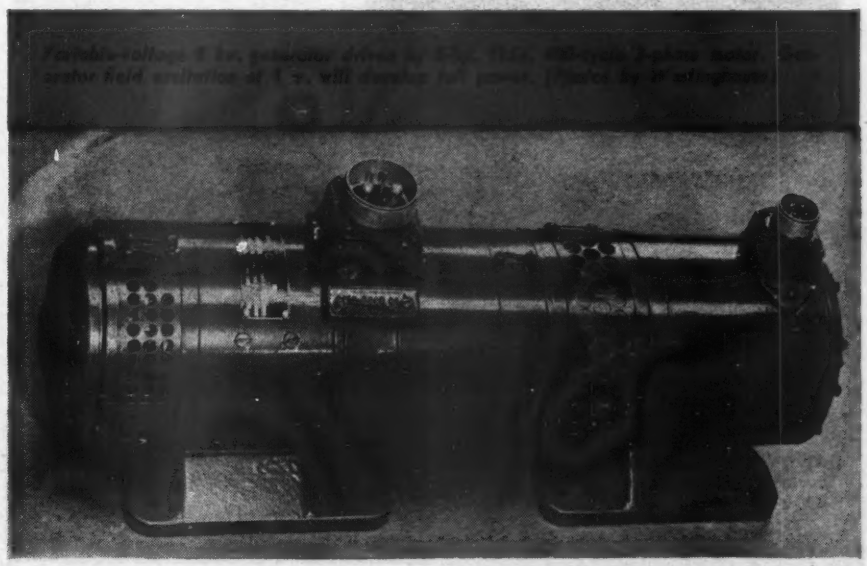
Military loads kept right on increasing, hence pressure grew for still higher voltages. However, the convenience of battery standby power discouraged most attempts to promote the use of d.c. at voltages higher than would be practicable for aircraft batteries. It was also feared that any substantial increase in d.c. voltage would lead to trouble at high altitudes. A few of the farsighted who advocated a.c. systems as a means of going to higher voltages had even more objections to overcome; not only would battery standby power be impossible, but also the simplicity of parallel operation of d.c. generators would be replaced by the complications of synchronizing and paralleling alternators.

It is desirable to review the status of 24v. d.c. systems before explaining the reasons why a.c. has become a military necessity. During the past few years, remarkable improvements have been made in 28.5 and 30v. generators. Outputs of 100, 200, and finally 300 amp. were obtained from a single engine-mounted generator. The 300-amp. rating was made possible by the 4,000/10,000-rpm. generator takeoff provided on new-model engines, and it now appears that this high-speed takeoff will permit a rating of 400 amp. on a generator of 6½ in. dia. and 14 in. long.

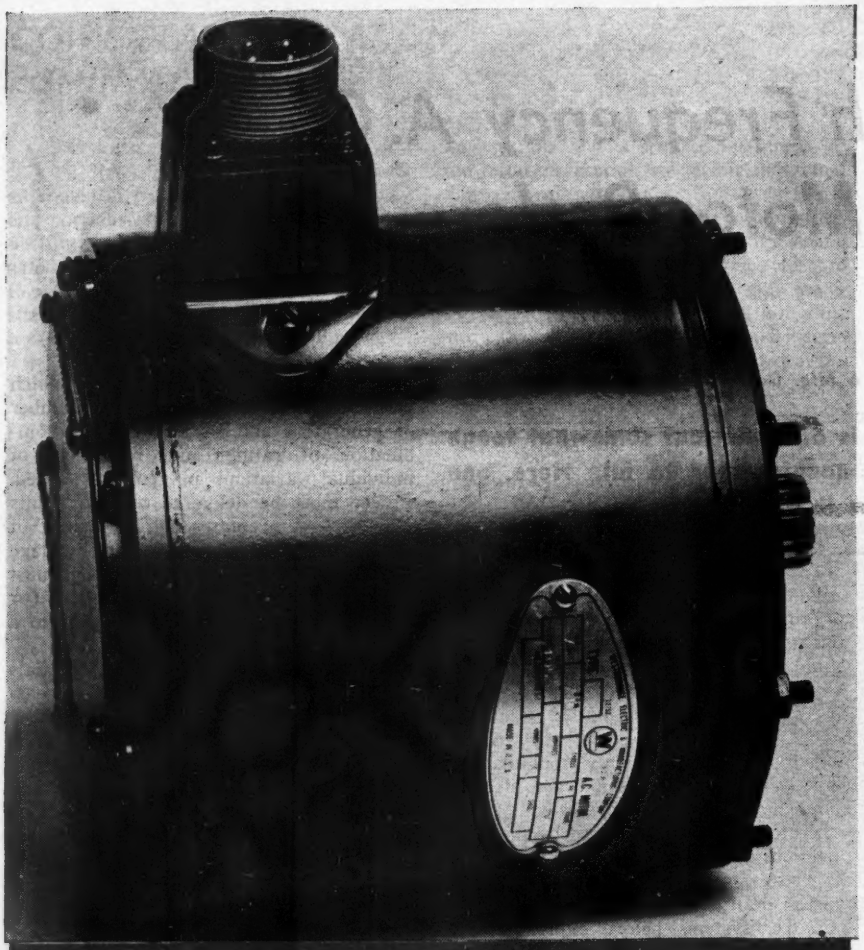
All of these generators are used with load-responsive voltage regulators which permit parallel operation of any number of generators and batteries in any combination of ratings and regardless of individual variations in generator speed. Power must be delivered to load points without loss of more than 3 percent of bus voltage. Normal operating voltage is about 27, consequently the wiring must have sufficient cross-section of copper (or aluminum) to limit the voltage drop to a little over 0.75.

Use of direct current at potentials higher than 27v. as a method of increasing system capacity has already been mentioned. The importance of using the highest possible voltage lies in the fact that each time voltage is doubled, current transmitted is doubled—and double current at double voltage means that the power transmitted is quadrupled. Such voltage doubling can be repeated until it is too high to control safely, but at some point, heat dissipation rather than voltage regulation will become the limiting factor so that no further increase in current density is permissible, although the power still increases directly with voltage.

Because of arcing problems, no d.c. voltage higher than 125 has been proposed for aircraft service, yet from voltage-weight considerations alone, this is still too low for minimum weight. At least one low-altitude airplane with a 120v. d.c. system has been built and used successfully for service up to 15,000 ft. At 120v., a given conductor will carry from 4 to 16 times the power carried at 30v.;



*The author acknowledges the assistance of C. G. Veinott and D. W. Exner, both of the design engineering department, Lima Div., Westinghouse Electric & Mfg. Co., and of J. C. Cunningham, central station engineer of Westinghouse's E. Pittsburgh Works, in offering valuable suggestions and in checking certain of the technical points covered.



Enclosed motor for intermittent duty. It is a 7-hp. 195v. 400-cycle 3-phase 7,400-rpm. plant.

Left: Industrial 1/6-hp. 7500-rpm. 60-cycle 1750-rpm. motor. Right: ½-hp. 24,000 400-cycle 11,000-rpm. aircraft motor. Illustrated is weight and space saving possible use of 400-cycle current. Both motors are 4-pole.

4 times if heating is the sole factor, or 16 times if voltage regulation is the consideration. Weight reductions are substantial although far from the ultimate possibilities.

With high d.c. voltages at altitudes above 20,000 ft., the problems of circuit interruption and motor commutation become extremely important. Because of these problems it does not now appear practicable to use even the comparatively low d.c. voltage of 120 on military aircraft which must operate at 40,000 to 50,000 ft. It is a well-established fact that destructive arcs will be maintained by lower and lower voltages as air density decreases. Actual voltage for a given air density varies according to length of arc, current carried, and composition of the electrodes. At 40,000 ft., arcs of considerable length will be maintained by 50 to 75v.

It will be seen that arcing prevents the use of even moderate d.c. voltage unless there is pressurization or large multigap switching devices are developed. Even then, such devices cannot prevent projectiles from cutting circuits and causing arcs which might set an airplane on fire, although 120v. d.c. altitude tests indicate that most such faults will burn clear and be extinguished.

Even if switching problems are solved, successful commutation on small d.c. motors requires a large increase in the number of commutator bars between brushes over the numbers now used on 30v. motors, and this will usually necessitate a reduction in the number of poles and an increase in the weight of the motor, in spite of the smaller current to be carried by the brushes.

However, weight savings in the use of high-voltage distribution are too great to overlook. Some way must be found to utilize a substantially higher voltage. The only way that appears possible is a change to a.c. Altitude tests indicate that the use of a.c. at 200v. does not involve any major circuit-interruption problems even at 50,000 ft. Thus a.c. at once overcomes the two major objections to the use of high-voltage d.c. at ceiling altitudes. Further, a.c. arcs are much easier to extinguish than d.c. at corresponding voltages and currents, and a.c. motors do not have commutators or commutation problems.

Saving in weight of distribution copper by using 200 in place of 30v. amounts to hundreds of pounds on airplanes for which a.c. will be required. Admittedly, the use of a.c. brings new problems, and it will be necessary to show how they will be solved before alternating current can be finally proved to be both desirable and practicable.

It is necessary to determine what handicap, if any, will result by changing from a 30v. d.c. system to a 200 a.c. system.

The first important use of electric power on aircraft was for radio operation. Radio is still a vital load, but radio power problems have undergone many changes. Early transmitting tubes required relatively high voltages, and many early aircraft radio transmitters used a.c. power

supplies because voltages as high as 2,000 were readily obtained by the use of transformers and rectifiers, whereas d.c. dynamotors or generators rated at even 1,000v. were, at that time, of questionable dependability.

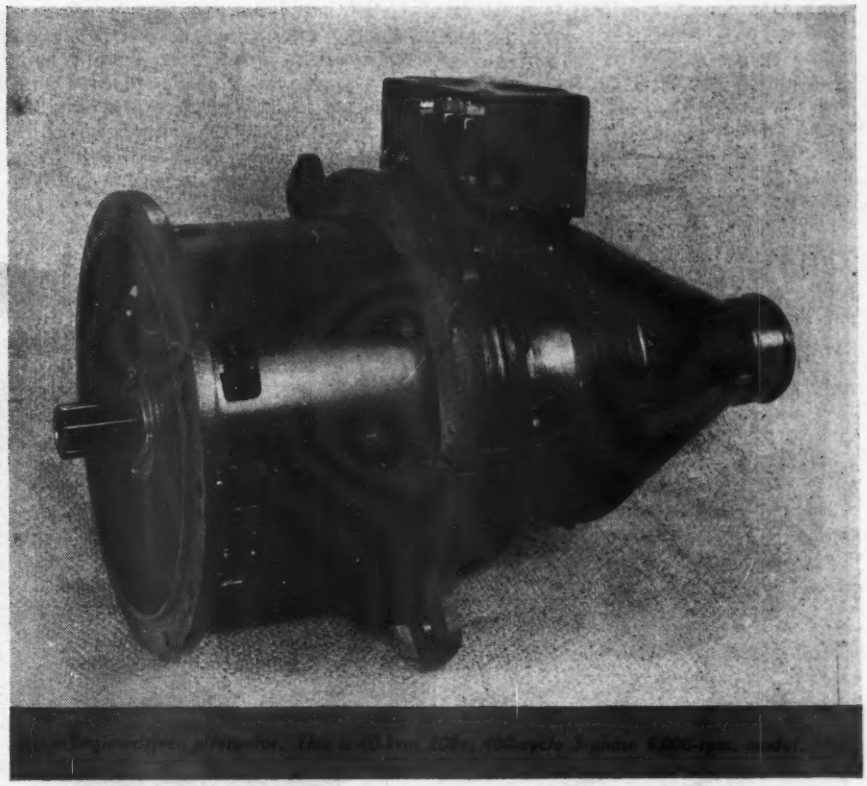
Advances in radio and tube design have greatly reduced power requirements. Moderately high-power tubes operating at reasonable voltages are available, and dynamotors have been improved to permit high voltage with reliability so that there is little handicap involved from present d.c. systems. Because dynamotors permit operation when the engines are not running, the great majority of aircraft radios are now operated from d.c. dynamotors. The Navy, however, still favors a.c. for much of its radio equipment and uses several types of double-output generators which supply both high-frequency power for radio and 30v. power for airplane. The a.c. power is also an absolute essential for some new equipment which require several thousand volts (far more than can be obtained from small d.c. machines). It is therefore evident that with some redesign of the smaller sets, radio requirements can easily be supplied from an a.c. system and that, moreover, a.c. power is actually necessary and now has to be provided by special generators, or by d.c. to a.c. inverters when some of the higher powered special equipment is operated on a d.c. equipped airplane. Requirements for emergency radio operation still necessary can be met by small auxiliary sets which supply power only when on the ground and which are needed for ground operation of other accessories.

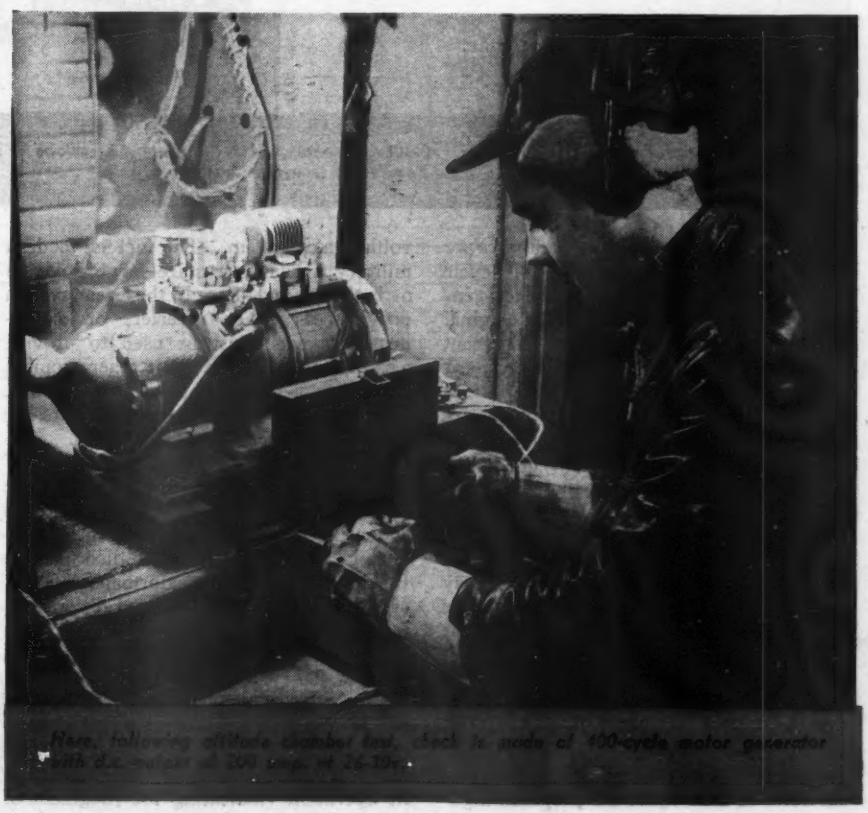
The designer is more concerned with the problems of power-driven actuators than he is with radio equipment. As airplanes grow, many functions must be converted from manual to power operation. Brakes, flaps, bomb-bay doors, pumps, landing gear mechanisms, and many other devices must be power actuated. The controversy between the proponents of hydraulic and electric operation will probably overshadow any consideration of the relative merits of a.c. versus d.c. One important consideration for military airplanes is that wiring is less vulnerable to combat damage than hydraulic piping carrying inflammable fluid at 1,200 to 3,000 psi.

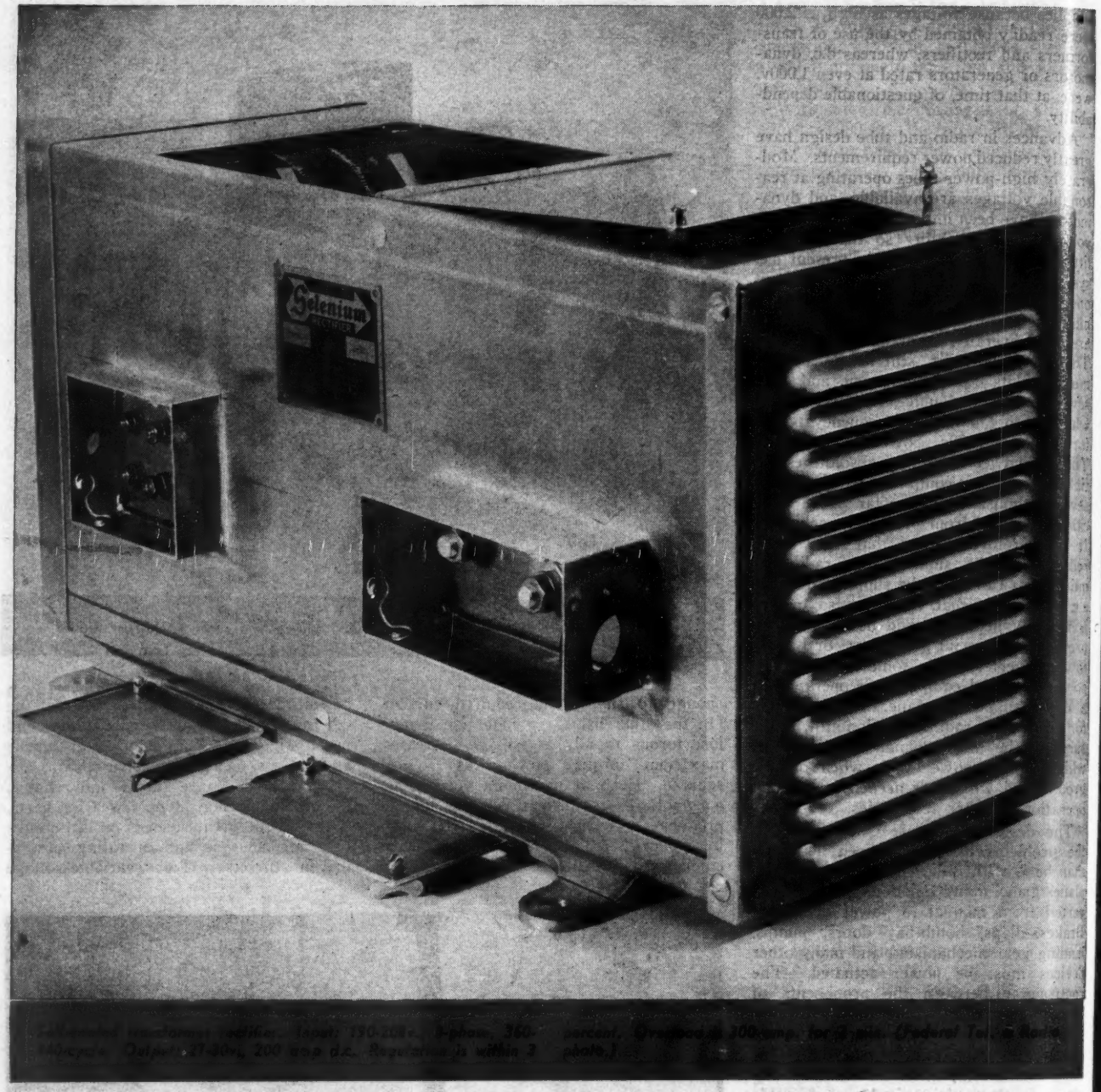
In general, electric apparatus appears to be more easily controlled by precision instruments, especially for positioning apparatus, while hydraulic apparatus, especially at low operating speeds, provides smoother operation and more direct application of heavy forces. Electric operation has definite advantages for remote control or for power transmission over any distance. An intermediate scheme makes use of electric transmission to a hydraulic pump and servo system located at the point of operation. A proposed application of this scheme is reported to have saved over 3 lb. per hp. compared to hydraulic transmission.

Series-wound d.c. motors are used for heavy-duty actuators, since they deliver their lb.-in. per amp. regardless of voltage, so long as the voltage is high enough to supply the required current. On the other hand, a.c. induction motors lose torque rapidly as voltage decreases, maximum torque varying as voltage squared. Even at maximum voltage, no a.c. motor is as efficient as a d.c. unit in producing torque on the basis of lb.-in./lb./kw. This should not be overemphasized, as the a.c. motor may still be considerably lighter than a low-voltage d.c. motor with its heavy commutator and brush rigging. For other than torque applications, a.c. motors have obvious advantages. They are simple and reliable, the bearings being the only wearing parts.

One of the greatest loads on large military airplanes is for operating power-driven turrets. Two variable-voltage







motor-generator sets are required per turret. When driven by a 400-cycle motor, one large turret-drive motor-generator set is 10 lb. lighter than the original 27v. design, a saving of about 13 percent of the original weight. The a.c. motor drive is especially suitable for pumps of all sorts. Precision gyroscopes already are often driven by a.c. motors to avoid precession effects such as might be caused by brush friction on d.c. motors or by fouling of bearings by carbon dust.

Regardless of the voltage selected there will undoubtedly be requirements for other voltages. Any number of voltages may be obtained with a.c. by means of static transformers; voltage transformations with d.c. require dynamotors or motor-generator sets if voltage control is necessary.

It is evident that these are not compelling reasons for either d.c. or a.c. systems, nor do they constitute appreciable obstacles in the way of the proposed high-voltage a.c. system. The fact is, modern military airplanes require large amounts of both a.c. and d.c. If the basic system provides d.c., then inverters or motor-generator sets must be used to provide a.c. for instruments and other combat equipment. If the supply provides a.c., then rectifiers or motor-generator sets are required for d.c. operated devices.

Two attempts were made by the AAF during the late 1930's to develop simple a.c. auxiliary engine-driven systems. An 800-cycle single-phase system using inductor alternators was installed on the Boeing XB-15. The performance of 800-cycle capacitor motors proved disappointing and there were also difficulties with system stability. Shortly thereafter, a 3-phase 400-cycle system with parallel operation of two 14-pole 12.5 kva. auxiliary-engine-driven alternators was installed in the Douglas XB-19. On the whole, the XB-19 power installation was successful, its operation vindicating the judgment of engineers who insisted that polyphase power would be essential for stable parallel operation of alternators and for the satisfactory operation of high-speed a.c. motors. The XB-19 was test flown in June 1941, and the performance of its electric system has been the basis for the new, larger, and more complete a.c. systems now being developed.

First requirements for a versatile and successful a.c. system are reasonably constant frequency and voltage. Variable-frequency a.c. has been seriously proposed. Variable-frequency power could be used for constant-torque induction motors by maintaining the system voltage proportional to frequency, but then radio or lamp loads could not be served and motor speeds would vary with the frequency. On the other hand, constant-voltage variable-frequency power, though suitable for radio or lamp loads, is not at all suitable for motor loads. Constant-voltage constant-frequency power is therefore neces-

sary if all types of loads are to be supplied.

The decision of the AAF that the main alternators must be driven from the main engines and not from speed-regulated auxiliaries vastly increased the difficulties of providing a constant-frequency a.c. system, since the power takeoff which drives the alternator will operate over a speed range from 2,100 to 8,100 r.p.m. A speed-governed variable-ratio drive is required which will maintain the alternator at 6,000 rpm., while the engine varies over a speed range of approximately four to one.

Frequencies from 200 to 800 cycles have been considered; 200, 240, 360, 400, and 800 cycles have each had strong advocates. When transformer and motor requirements are balanced against each other, the most favorable compromise lies between 200 and 400 cycles. There is little difference in weight between systems designated for either of these frequencies, but 400 cycles permits maximum motor speeds of 24,000 rpm., and such speeds are likely to be required for some gyroscope applications.

The highest possible speed with 200 cycles would be 12,000 rpm., and this would be with a two-pole motor. A 4-pole 400-cycle motor will give the same speed, with some reduction in weight because of the multipolar construction. Frequency of 400 cycles has now been definitely established, and there appears to be little possibility that any other frequency will be seriously proposed.

Polyphase power is imperative after the experiences with the XB-15 and XB-19, since motor loads and parallel operation will be of predominant importance. Of two- or three-phase power, three-phase gives the lightest overall weight and somewhat better motor performance, hence is an obvious choice. A grounded neutral is specified to assure some starting torque on motors even under the condition of one line shot away.

The grounded neutral gives line-to-neutral voltage for single-phase loads and also limits the voltage to line-to-neutral value in accidental contact with one of the lines, reducing danger to the crew from shock.

A line-to-line voltage of 208 at the generator was chosen after extensive altitude tests had established that this would provide "burn clear" characteristics in case of usual cable faults. Line-to-neutral potential is 120, providing standard voltage for such single-phase equipment as may be required.

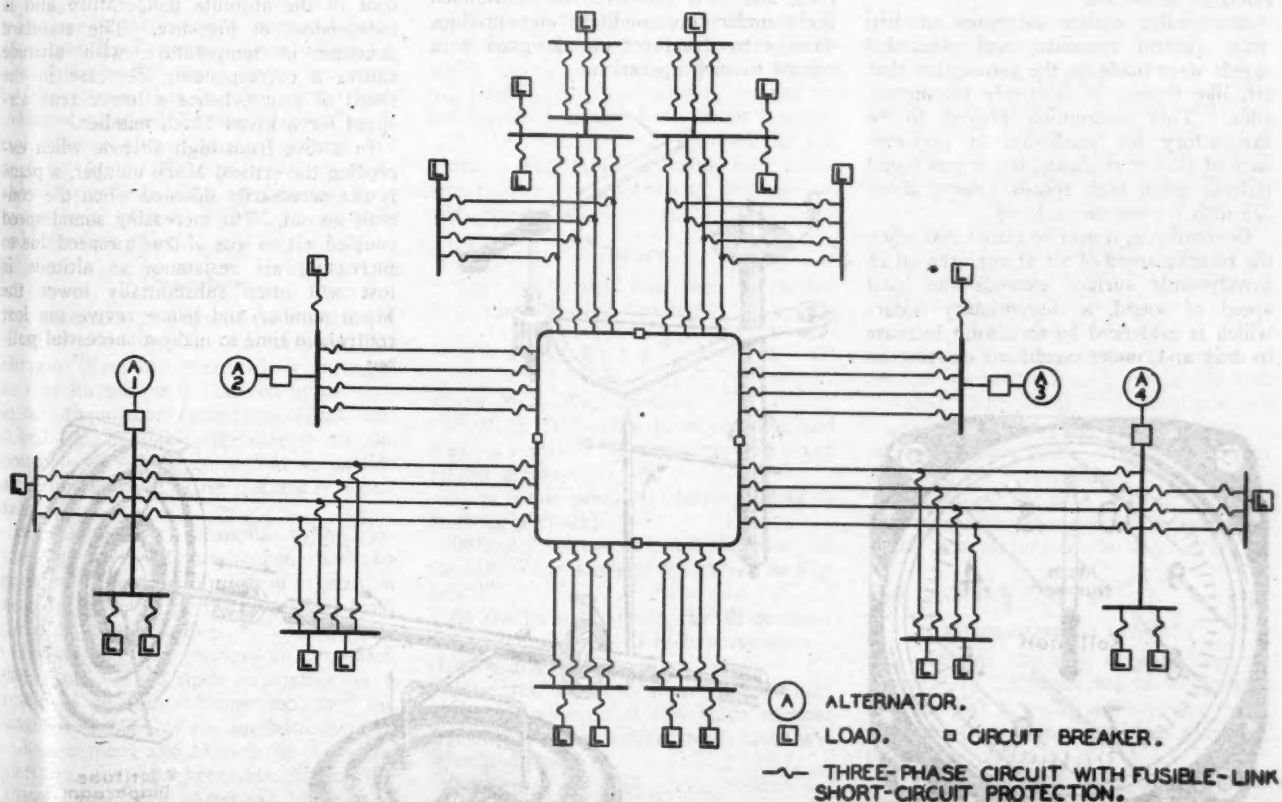
The question of number of generating units on each airplane has been debated extensively. Military considerations dictate that all essentials function when 50 percent of the equipment has been put out of action.

For this reason, several alternators of moderate rating are preferable to one or two capable of supplying the entire demand. Continued operation under conditions of severe damage from hostile fire requires maximum flexibility in making the output of any generator available to any load, either by parallel operation or by bus transfer switches. Multiple circuits for all vital feeders are required for the same reason.

The problem of driving an alternator at 6,000 rpm., while engine power-takeoff shaft varies from 2,100 to 8,100 rpm. is occupying the attention of many engineers. At present, hydraulic transmissions appear nearer final development than do mechanical friction devices or electromechanical transmissions. Surprisingly low weight and high efficiency has been achieved in preliminary tests of at least one hydraulic transmission. Low weight has been achieved by gearing up the hydraulic mechanism to operate at extremely high speed. High efficiency was attained by an ingenious arrangement which provides power transmission without any hydraulic work at an arbitrarily selected point midway in the speed range.

All variable-ratio drives change ratio with load because of two factors: First, there is some slippage; second, stresses are high and there is elastic deformation which cuts down the stroke slightly as torque increases. This tendency to shirk load is an important advantage when alternators are operated in parallel, since it will help distribute sudden load changes while the governors are adjusting the drive controls for the new conditions.

A further safeguard will be provided by an over-running clutch incorporated in the drive to prevent any possibility of reverse loading during parallel operation. Such reverse loading would take power required for maintaining load and expend it in a futile attempt to raise the speed of the main propulsion engines through the drive.



MACHMETER MEASURES SAFE TOP SPEEDS

Here is a timely presentation of the principles of operation and mathematical theory behind the Machmeter—the instrument which provides a measure of the safe maximum speed for those present-day aircraft which in level flight are gradually approaching the speed of sound and which in some maneuvers reach or possibly exceed this critical speed.

THE TREND for aircraft to operate at speeds in the vicinity of the speed of sound has prompted designers to consider a phase of aerodynamics, which, for lower speeds, may safely be neglected.

Previously, design estimates of lift, drag, control response, and placarded speeds were made on the assumption that air, like liquids, is relatively incompressible. This assumption proved to be satisfactory for prediction of performance of slower airplanes, but it was found lacking when high speeds (above about 375 mph.) were encountered.

Generalizing, it may be stated that when the relative speed of air at any area on an aerodynamic surface exceeds the local speed of sound, a discontinuity occurs which is evidenced by an abrupt increase in drag and, under conditions existing on wings and tail of current aircraft, the occurrence of shock waves.

Concurrent with the appearance of shock waves, the controls, due to the redistribution of pressures over the airfoils, lose their effectiveness. Continued flight under this condition may produce damage to structures not designed with regard to such operation.

Hence, in testing planes at speeds near the speed of sound, it is desirable to know the relation between the two speeds, without the necessity of calculations made from several observations.

The Mach number (after an Austrian physicist who pioneered in the field of compressibility) is the ratio of true airspeed to the local speed of sound. The Kollsman Machmeter is calibrated to indicate Mach numbers from .3 to 1.0 (sound speed) with an accuracy of ± .01 from the calculated value.

In flight, the Machmeter may be used as a measure of the airspeed and altitude at which shock waves start to develop. With a carefully streamlined pursuit ship, the local relative velocity of the air will exceed the true airspeed by only a small percentage, hence the aircraft may approach quite close to sonic speed (a Mach number of .8 or more) before shock waves appear. In contrast, with a blunt-nosed cargo carrier or bomber with thick wings and irregular contour, the effects will become noticeable at a considerably lower value.

The Mach number at which shock waves first appear is practically constant for a given airplane, being dependent chiefly on the geometry of the exterior surface, smoothness of skin, and to a lesser extent, on angle of attack.

However, the critical value will generally be reached at lower true airspeeds for higher altitudes, a fact at first appearing contrary to expectation, but which becomes rational when it is considered that sound speed varies with the square root of the absolute temperature and is independent of pressure. The standard decrease in temperature with altitude causes a corresponding decrease in the speed of sound, hence a lower true airspeed for a given Mach number.

In a dive from high altitude when exceeding the critical Mach number, a plane is not necessarily doomed when the controls go out. The increasing sound speed coupled with a loss of true airspeed due to increasing air resistance as altitude is lost will often substantially lower the Mach number and hence revive the lost controls in time to make a successful pull-out.

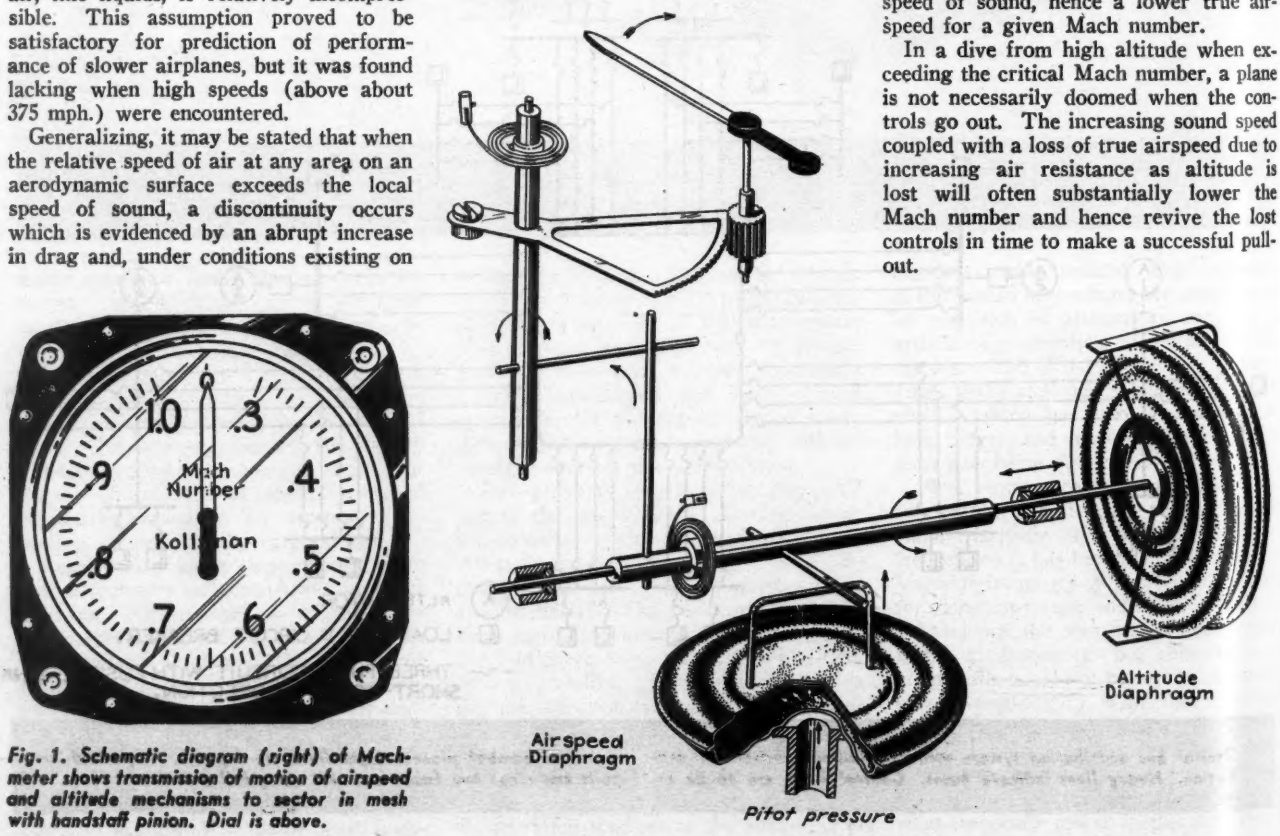


Fig. 1. Schematic diagram (right) of Machmeter shows transmission of motion of airspeed and altitude mechanisms to sector in mesh with handstaff pinion. Dial is above.

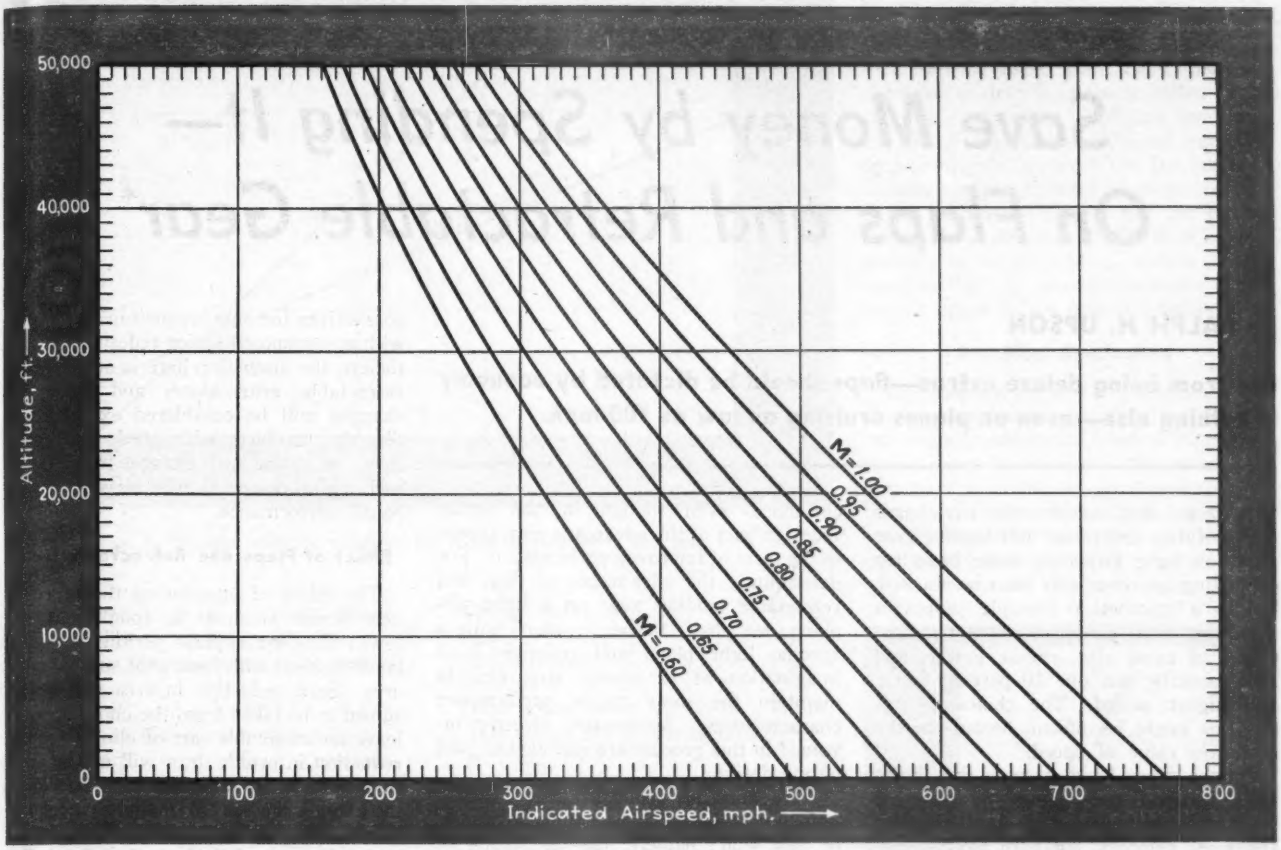


Fig. 2. Chart showing indicated airspeeds and altitudes for various Mach numbers.

In the past this was not common knowledge, and dives occurred from which the pilot presumably could have recovered had he known that in spite of the high indicated airspeed he had regained control. Other pilots, having trimmed full nose up in an effort to pull out while above the critical Mach number, lost their wings in a high G pullout, as controls suddenly took effect.

Operation

A schematic diagram of the Machmeter is shown in Fig. 1. An airspeed diaphragm (dynamic pressure) is arranged so that its motion is altered by an altimeter diaphragm (static pressure) followed by suitable amplification to the pointer. It is to be noted that no outside air temperature sensitive element is necessary.

The airspeed unit is similar to the conventional airspeed mechanism, and its sensitive diaphragm expands in proportion to the differential pressure received from the pitot and static lines.

The altitude unit employs an evacuated diaphragm, which upon expanding as a result of altitude change modifies the magnifying ratio of the mechanism.

As the speed and altitude of the plane increases, the pitot pressure causes the airspeed diaphragm to expand. When the altitude is increased, the altitude diaphragm expands, pushing the floating rocking shaft to a new position. This movement changes the leverage ratio between the sector lever and the rocking shaft lever. The movement of the rocking shaft is transmitted to the sector lever which rotates the sector in mesh with the handstaff pinion. A pointer fastened to the handstaff indicates the Mach number.

A thermometal fork attached to the altitude diaphragm provides full range temperature compensation for the altitude and airspeed diaphragms.

Theory

The Machmeter has been calibrated from the following formula:

$$M = 2.23607\sqrt{\left(1+\frac{\Delta P}{P}\right)^{.2857}-1} \quad (1)$$

where M = Mach number

ΔP = Difference between pitot and static pressures (corresponding to a given indicated airspeed) and

P = Static pressure (corresponding to a given altitude)

Indicated airspeeds and altitudes for various Mach numbers are shown in Fig. 2.

As the formula shows, the Mach number is a function of only two variables—altitude and pitot pressure.

The true airspeed may be computed from a knowledge of the Mach number and the free air temperature, since the relationship is:

$$M = \frac{V_t}{C}$$

$$\text{or,} \quad V_t = M \times C \quad (2)$$

where V_t is true airspeed, and C is speed of sound.

The speed of sound is a function of the absolute temperature only, and its value may be computed from:

$$C = 44.8\sqrt{T} \quad (3)$$

where C is expressed in mph. and T is the absolute Centigrade temperature of the free air. It has been proven experimentally and theoretically that a thermometer in moving air will not indicate the true air temperature. The error produced due to the adiabatic compression and the friction of the air moving past the sides of the temperature bulb is:

$$t = -0.8 \times 10^{-4} V_t^2 \quad (4)$$

where t is the temperature correction in degrees Centrigrade and V_t is the true airspeed. The factor 0.8 is empirical and dependent upon the shape and location of the temperature bulb. One procedure for obtaining the true airspeed is as follows:

1. Calculate the true airspeed from the following formula using the indicated absolute temperature of the free air:

$$V_t = 100.2789\sqrt{T_i\left[\left(1+\frac{\Delta P}{P}\right)^{.2857}-1\right]} \quad (5)$$

(from equations 1, 2, & 3)

2. Compute the true absolute free air temperature. The correction found from equation (4) is added algebraically to the indicated temperature and then converted to absolute value.

3. Calculate sound speed from (3) and multiply by indicated Mach number.

Use of the Machmeter indication eliminates the necessity of the resubstitution of the true absolute free air temperature into formula (5); instead, the simple equations (2) & (3) are used.

Save Money by Spending It— On Flaps and Retractable Gear*

By RALPH H. UPSON

Far from being deluxe extras—flaps should be dictated by economy if nothing else—even on planes cruising as low as 100 mph.

BEFORE DETERMINING the advantages of flaps and retractable landing gear on light airplanes, some basis for evaluating improvements must be reached. Taking a hypothetical example, suppose a purchaser must choose between two airplanes of equal size, engine power, and load capacity, but one 10 percent faster and higher priced. The choice in this situation might be difficult because of the uncertain value of speed.

On the other hand, assume the choice rests between two planes of differing size and engine power, one slightly cleaner and more compact, but both having substantially equal performance figures. Since the smaller plane has lower power, it would have less fuel consumption, lower upkeep cost, and other operating advantages. As the smaller craft is lower in cost, there would be no argument as to which offered the best marketing potential, the higher priced plane would have no sales appeal.

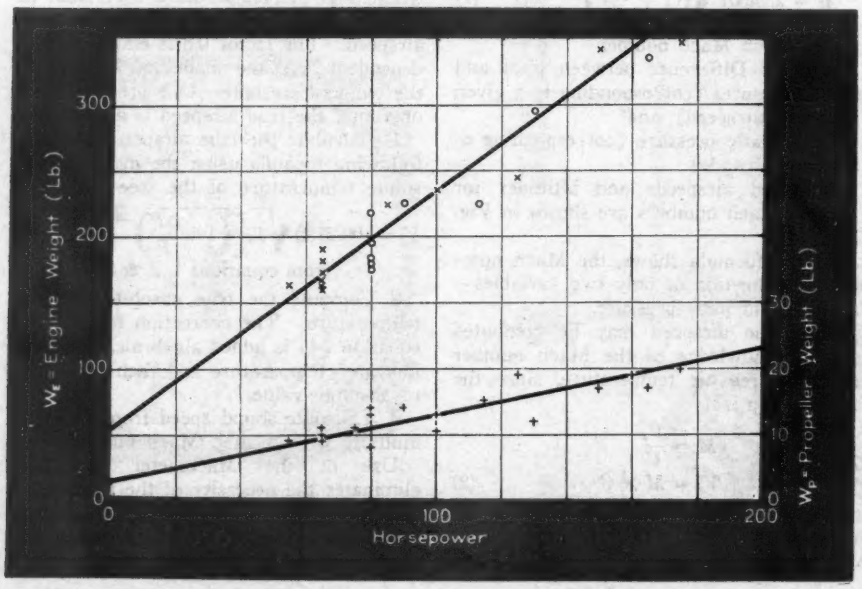
The illustrations just given show that the only fair way to evaluate design improvements is by reduction to equal performance, even though in the actual redesign part of the advantage may appear in the form of improved performance. For determining the advantages of flaps and retractable landing gear on a light airplane, we shall, therefore, start with a specific light plane and redesign it in imagination as to power, size, etc., to maintain the same major performance characteristics. Accessories directly involved in this process are included as part of the design.

Here must be avoided a pitfall which unfortunately is all too common in studies of this kind; namely, the temptation of including various changes and improvements quite foreign to the specific items under consideration. For example, it may be conveniently argued that because an existing lower-power engine is of substantially the same weight (such as due to a lower compression ratio) there is no weight saving in the reduction of drag and power. On the other hand, a fictitiously good case might be made for flaps and retractable gear by throwing in at the same time an improved wing section and other incidental refinements.

From a practical point of view it is quite in line to consider all worthwhile possibilities for improvement in connection with any proposed major redesign. Nevertheless, the discussion here is on flaps and retractable gear alone, and no other changes will be considered except those directly involved with these particular items, including such changes in wing size and engine power as will serve to retain equal performance.

* Reprint from paper presented before National Light Aircraft Meeting of Institute of Aeronautical Sciences.

Fig. 1. Author's graphic representation of engine and propeller weights.



Effect of Flaps and Retractable Gear

The effect of introducing the proposed new design elements is roughly as follows: The use of flaps permits the same landing speed with somewhat smaller wing area. Such reduction in area will be assumed to be taken from the chord so as to leave an acceptable rate of climb; but the reduction in profile drag will not be quite in proportion to the area because of the thickness required to maintain adequate spar depth and that added surface irregularity along the flap hinge line. In similar manner the weight saving is in part counter-balanced by the addition of hinges, control connections, and a slightly increased beam weight. Nevertheless, an appreciable saving in drag and weight can be made.

In the case of the retractable gear a substantial direct increase in weight is involved. The saving in drag, however, together with that permitted by the flaps, makes it possible with equivalent design to reduce the engine power and weight and, for the same range, the fuel supply and tank capacity. With similar power plant design, the cooling drag is also reduced. These savings in turn continue a beneficent cycle which permits still further reduction in wing area, drag, and structural weight which, in the end, results in greater savings than might initially be apparent.

Power Plant Weight

As the principal ultimate savings must come out of the power plant, an important preliminary is to establish a fair basis of weight variation with required rated horsepower. For this purpose a plot of existing engines in the low-to-medium horsepower class is presented in Fig. 1, from which it appears that the average engine weight can be expressed as

$$W_e = 55 + 1.8\,\text{hp.} \qquad (1)$$

This formula does not of course give the weight of any specific engine, nor is it valid much beyond the range in which we are interested. It would obviously not apply, for example, to an extremely low-power engine such as used in models.

A plot of corresponding propeller weights is shown in the same figure. Ex-

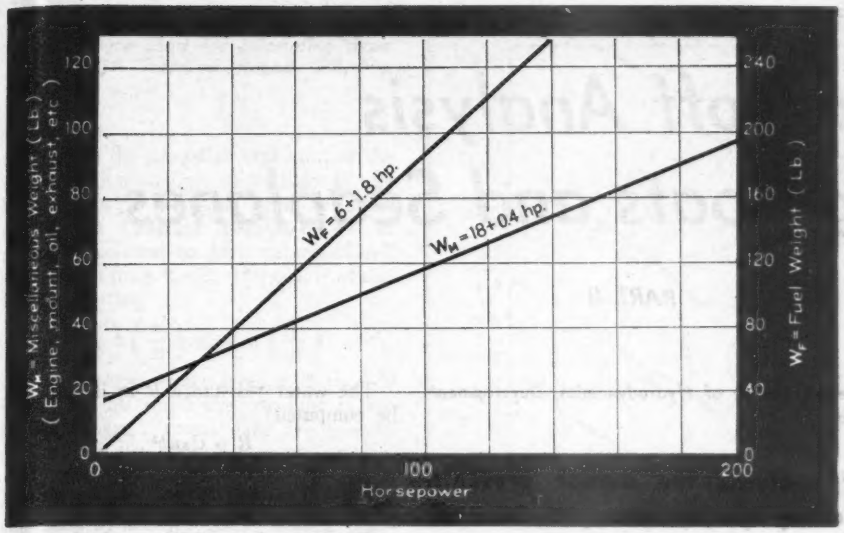


Fig. 2. Weight equation solutions for miscellaneous parts and fuel.

pressed in the form of a similar linear function, valid up to about 200 hp., the expression for the mean propeller weight becomes:

$$W_p = 3 + 0.1 \text{ hp.} \qquad (2)$$

Fig. 2 shows that further allowance for engine mount, oil, exhaust, cowling, scoops and miscellaneous, is estimated as:

$$W_m = 18 + 0.4 \text{ hp.} \qquad (3)$$

If cruising power is a given proportion of maximum or rated power, and the specific fuel consumption per horsepower-hour remains the same; then, for the same cruising speed and range, the required tank capacity will of course be proportional to horsepower. The following formula for fuel weight, shown graphically in Fig. 2, including a small allowance for the tank weight, is adopted simply because it fits the capacity of the particular airplane that will be used as an example:

$$W_f = 6 + 1.8 \text{ hp.} \qquad (4)$$

Summing up equations (1 to 4) that have to do with the powerplant, we get, as shown in Fig. 3;

$$W_{hp.} = 82 + 4.1 \text{ hp.} \qquad (5)$$

A similar principle, based on gross weight, is followed for the wing[1] and for the landing gear. For equal gross weight, the retractable landing gear is assumed 40 percent heavier than the fixed type, including wing reinforcement around the wheel wells.

Application to a Specific Airplane

The airplane chosen as an example has the following general characteristics: Two-place; low-wing, untapered cantilever; tractor monoplane with fixed tricycle landing gear; no flaps; 80 hp.; gross weight 1,300 lb.; weight empty, 830 lb.; wing area, 143 sq.ft.; span, 30 ft.; airfoil section, NACA 23013; fuel capacity, 23 gal.; assumed cruising speed, 100 mph. at SL, giving an operating Reynolds number of about 4×10^6.

The above formulas lead to the following weights for the power plant elements, which are very close to the actual:

Engine	199 lb.
Propeller	11
Fuel and tank	150
Mount, etc.	50
Total power plant wt.	410 lb.
(Of which 328 lb. varies linearly with the hp.)	

By employing sealed simple (or split) flaps extending out half-way from the center to the tip, the max. C_L can be increased about 28 percent (max. C_L from 1.4 to 1.79)[2]. Including the effect of reduced weight, the corresponding reduction in wing chord and area is 27 percent, and the profile drag reduction about 19 percent. Due to factors previously mentioned, it is conservatively estimated that the reduction in wing weight is only 15 percent. For this purpose, the portion of the tail which varies with the wing, estimated at 10 percent of the wing weight and drag (see footnote 1), is treated as if part of the wing. Table I gives the comparison

[1] "Performance Dictates Designs" by R. H. Upson, *Journal of the Aeronautical Sciences, Vol. 7, No. 9, July 1940.*

[2] "Tests in the Variable Density Wind Tunnel of the NACA 23012 Airfoil with Plain and Split Flaps" by Ira H. Abbott and Harry Greenberg, *Technical Report* No. 661, NACA, Jan. 21, 1938.

Table I—Comparison of Weight and Drag Between Plane With Flaps and Retractable Gear and One Without

A = Airplane in its present condition with fixed landing gear and no flaps.
B = Same with flaps and retractable gear.
The weights are given in pounds, and the drag in equivalent drag area (D/q estimated).

	Wt. (Lb.)		Drag (ft.²)	
	A	B	A	B
Wing + 10 percent	268	228	1.6	1.3
Landing gear	86	115	.7	.1
Power plant (incl. fuel)	410	344	.6	.5
Fuselage structure	80	77	1.8	1.8
Balance (constant)	456	456	.3	.3
Gross wt. & drag area	1,300	1,220	5.0	4.0

Weight saving: 28 lb. fuel; 38 lb. of power plant; 43 lb. of structure; against 129 lb. increase in landing gear.

in the elements affected by introducing flaps and retractable gear into the same airplane:

It may be noted that the 20 percent reduction in drag is of the so-called parasite type, but nearly 12 percent reduction of induced drag is also obtained from the decreased gross weight. The combination permits a slight increase of propeller efficiency sufficient to make the net power saving about 20 percent. The final engine power thus becomes 64 hp. which, substituted in Eq. (5), checks the power plant weight figure in the second column.

Practical Realization

The cheapest method of providing flaps on a conventional light plane is to duplicate the ailerons on the inboard wing portions. Even for a wing of the same size, it is hard to show any increased cost on this basis. On the other hand, any one of several improved flap types would give results still better than the simple flaps under discussion. The new wing is assumed to be increased in thickness ratio from 13 to 16 percent, the flaps being 20 percent of the wing chord. The ailerons are reduced slightly in span, but given a greater angular movement to retain a similar measure of control.

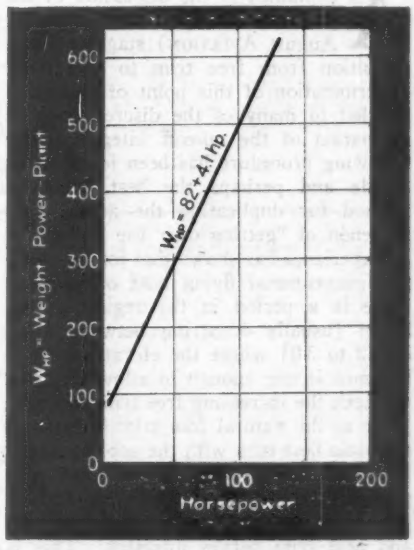


Fig. 3. Graphic representation of summation of all power plant equations.

It happens that the new engine power of 64 hp. is approximately in line with several engines on the market. Hence if a substantially higher power is retained, it would be to get increased performance.

An equivalent choice of smaller capacity wheels and tires is apparently not available. Nevertheless, the nominal allowance made for an imaginary reduction gives the fairest possible comparison. In this particular case, the maximum wing thickness of seven inches is insufficient to house completely any of the existing desirable wheel and tire sizes. With realization of the substantial benefits to be had from retractable gear, it is to be hoped that wheels and tires suitable for the purpose will soon be made available.

(*Turn to page* 241)

Takeoff Analysis For Flying Boats and Seaplanes

PART II

By ERNEST G. STOUT, *Staff Engineer in charge of Hydrodynamics, Development Design Staff, Consolidated Vultee Aircraft Corp.*

Concluding his two-part takeoff analysis, the author presents varied computation methods, including specific examples for still air and for a 15 mph. headwind.*

AS explained in the discussion of the stages of takeoff (Part I, page 150 August AVIATION) stage two is a transition from free trim to best trim. Determination of this point of transition has led to many of the discrepancies in evaluation of the takeoff integral. The following procedure has been found to be simple and perhaps the best empirical method for duplicating the actual phenomenon of "getting over the hump."

Experience has shown that for the average conventional flying boat or seaplane there is a period in the region of the hump (usually occurring between a C_V of 2.2 to 3.0) where the elevator control becomes strong enough to allow the pilot to check the increasing free trim at hump, prior to the natural free trim hump, and maintain best trim with the accompanying lower resistance. Experience has also shown that this may usually be accomplished at the point where the free trim and best trim curves intersect. This is illustrated in Fig. 4. The decrease in resistance resulting from maintaining best trim as soon as possible is considerable.

The best procedure for determining where to shift is to obtain both free trim and best trim in this hump region. This procedure is illustrated in Table III:

Table III—Determination of Shift to Best Trim

C_V	Trim in Degrees Free	Best
2.0	7.3	
2.2	8.0	
2.4	9.1	
*2.6		9.7
2.8		9.0
3.0		8.4

* Shift to best trim made here.

Upon determining the intersection point, all trims above this value, both free and best, are scored out and do not enter into the integration.

With C_V and C_Δ known, hydrodynamic resistance coefficient, C_R, can be obtained. Take care, however, to use the correct curve of free trim or best trim as the case may be.

The water resistance R in lb. can then be computed:

$$R = C_R w b^3 \qquad (25)$$

which is derived from equation (13)[1], with the values entered in the column provided.

For the values of C_L used, determine values of aerodynamic drag coefficient C_L from the aerodynamic characteristics curves corrected from ground effect. Given wing area S and speed in mph., then V, (aerodynamic drag in lb.) will be:

$$D = .00256\, C_D S V^2 \qquad (26)$$

Total resistance is obtained by adding hydrodynamic and aerodynamic resistance $R + D$.

Next step is to find the thrust available at each increment of velocity. Variation of thrust with velocity is a function of the propeller. Propeller characteristics are generally expressed as functions of the following non-dimensional parameters:

1. *Activity Factor* (AF.) is a non-dimensional function of the propeller planform and expresses the capacity of the blade elements for absorbing power, independent of the number of blades. It is an index between propeller blades of varying solidity and is defined by the integral:

$$AF = \frac{100{,}000}{16} \int_{\frac{r}{R}=0.20}^{\frac{r}{R}=1.0} \left(\frac{b}{D}\right)\left(\frac{r}{R}\right)^3 d\left(\frac{r}{R}\right) \qquad (27)$$

* This article is taken from material to appear in Mr. Stout's forthcoming book to be published by McGraw-Hill Book Co.

[1] See Part I, page 150, August AVIATION, for Equations (1) through (24).

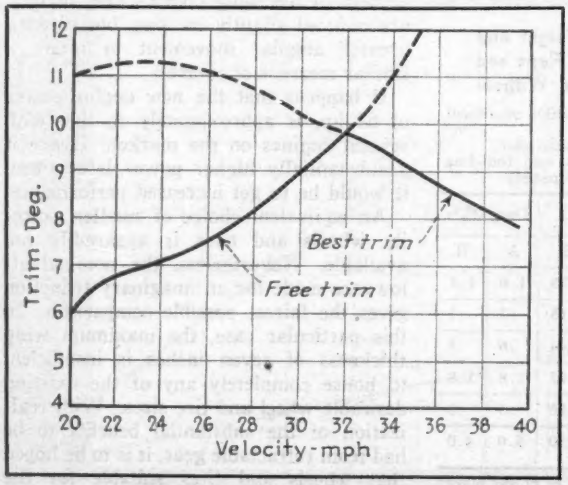


Fig. 4. Plot showing typical variation of free trim and best trim with velocity.

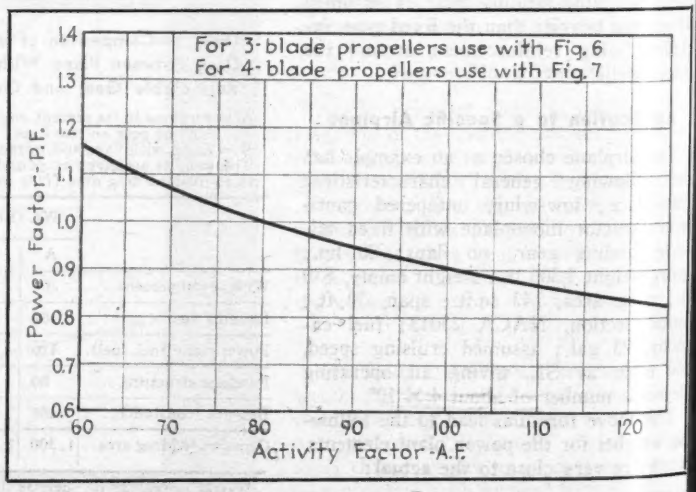


Fig. 5. Graphic representation of variation of power factor with propeller blade activity factor.

Fig. 6. Three blade propeller performance chart for calculating thrust (NACA Technical Report 640, Fig. 11).

where D is the propeller diameter, R the radius of the propeller, r the radius of any blade element, b the blade width at radius r, and the constant 100,000/16 is an arbitrary constant to give values of AF a convenient magnitude. Integral is evaluated by plotting

$$\left(\frac{b}{D}\right)\left(\frac{r}{R}\right)^3 \text{ against } \left(\frac{r}{R}\right)$$

Area under this curve from $r/R = 0.20$ to $r/R = 1.0$ times the constant is the activity factor. These data are usually supplied by the propeller manufacturer.

2. *Power Factor* (P_f) modifies the charted propeller efficiency values for the difference in activity factor (blade planform) of the test propeller, from which the charts were drawn, and the propeller under consideration. Correction is unity when these values coincide. The power factor has been determined experimentally and plotted as a function of activity factor in Fig. 5. It is applied directly as a correction to determine power coefficient, (C_p).

3. *Power Coefficient* (C_p) is defined as:

$$C_p = \frac{5 \times 10^{10} \times BHP \times P_f}{\sigma \times N^3 \times D^5} \qquad (28)$$

Where BHP. is the brake horsepower per engine, σ, the air density ratio p/p_0 (unity at sea level), N the propeller *RPM*, (engine *RPM*, × gear ratio), and D the propeller diameter in ft.

4. *Thrust Coefficient* (C_T) is defined by the expression:

$$C_T = \frac{T}{\rho n^2 D^4} \qquad (29)$$

where T is the thrust in pounds, ρ the density of the air in slugs per cubic foot (equal to .002378 at sea level and standard conditions), and n the propeller RPS. Typical values for C_T are plotted in Fig. 6, and Fig. 7 for three blade and four blade propellers, respectively.[8]

These charts, when the value of C_T obtained is reduced 10 percent for scale effect and body interference, have been found to give excellent correlation with full scale, both with three and four blade propellers.

5. *Advance Ration* (J) is defined as:

$$J = \frac{88V}{ND} \qquad (30)$$

where V is in mph., D is propeller diameter in ft., and N is propeller RPM. (engine RPM. × gear ratio).

Making use of these parameters, the thrust fall off is computed as follows:

[8] Edwin P. Hartman and David Bierman, "The Aerodynamic Characteristics of Full-Scale Propellers Having 2, 3, and 4 Blades of Clark Y and RAF 6 Airfoil Sections," NACA Technical Report No. 640, 1938.

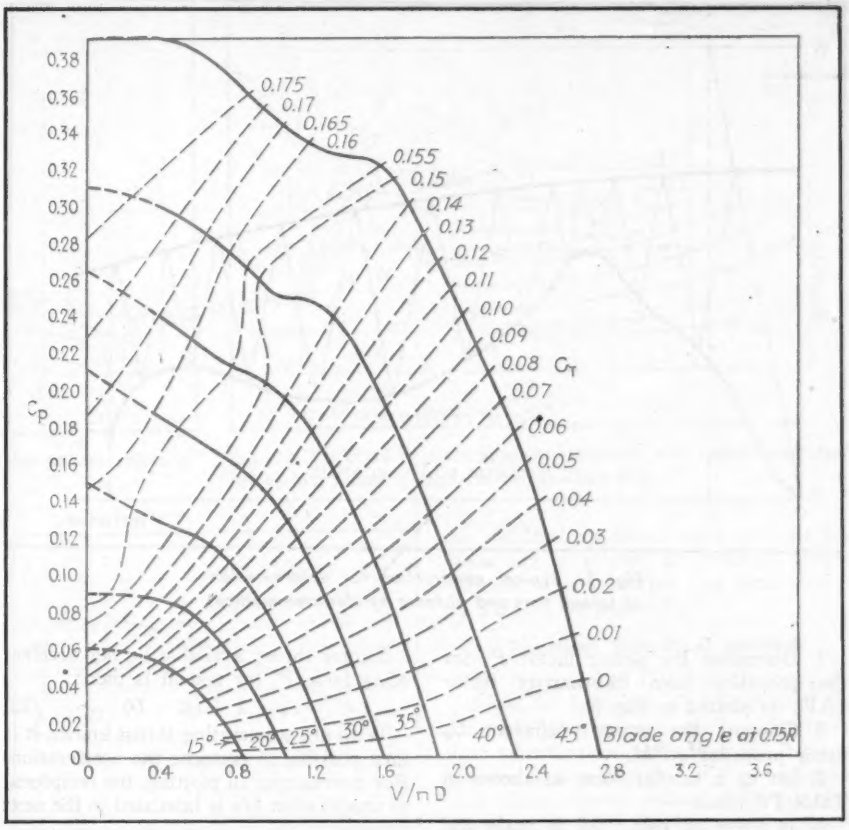
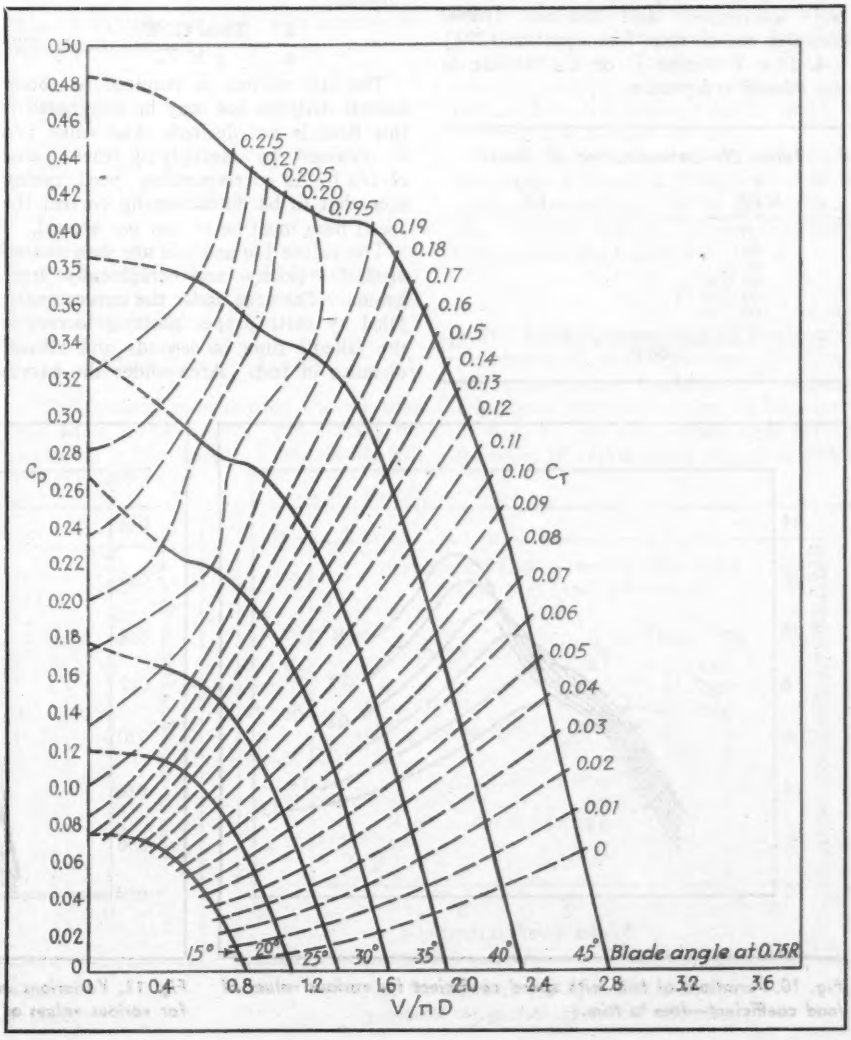


Fig. 7. Four blade propeller performance chart for calculating thrust (NACA Technical Report 640, Fig. 11).



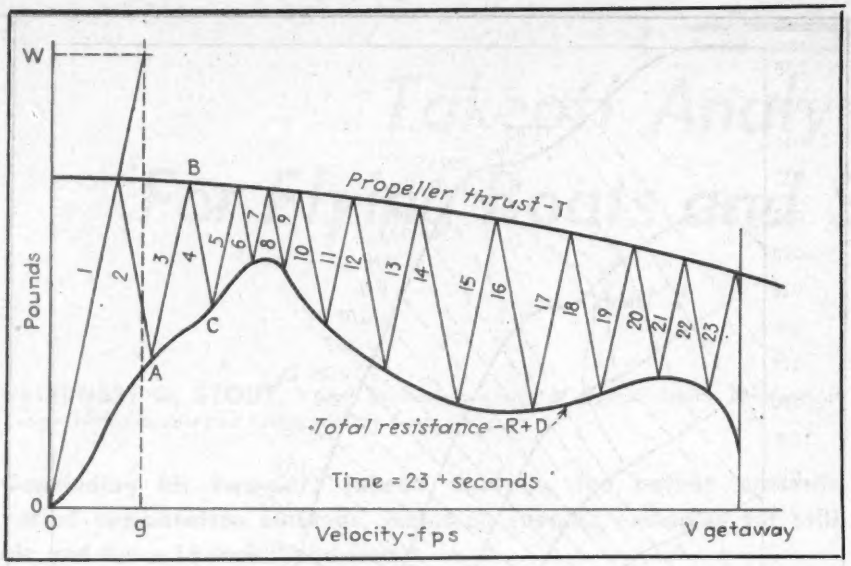


Fig. 8. Typical construction for determination of takeoff time and distance by Hermann method.

1. Determine the power factor P_f for the propeller from its activity factor (AF) as plotted in Fig. 5.
2. Compute the power coefficient C_T using propeller *RPM*.
3. Set up a tabular form as shown in Table IV where—

N is propeller rpm.; 0.9 is scale and body correction; and constant 1/3600 converts rps. to rpm. [see equation (29)]

4. Plot T versus V or C_T for use in the takeoff integration.

Table IV—Determination of Thrust

V MPH.	J	C_T	T LB.
0			
20			
40			
60			
80			
100			

$$T = \frac{\rho\ N^2\ D_4 \times \text{no. engines} \times 0.9\ C_T}{3600\ P_f} \qquad (31)$$

Excess thrust available or net accelerating force T_a for takeoff is then:

$$T_a = T - (R + D) \qquad (32)$$

With net accelerating thrust known it is then possible to compute the acceleration. For convenience in plotting, the reciprocal of acceleration $1/a$ is tabulated in the next column:

$$\frac{1}{a} = \frac{\text{Total G. W.}}{g \times T_a} \qquad (33)$$

The last column is required to obtain takeoff distance but may be eliminated if this item is not desired. The value v/a is obtained by multiplying each value of $1/a$ by its corresponding speed, taking note that to be dimensionally correct the speed here must be in feet per second.

The values $1/a$ and v/a are then plotted against velocity and graphically integrated. The area under the curves multiplied by their proper plotting factors is the takeoff time in seconds and takeoff distance in feet. Area under the curves

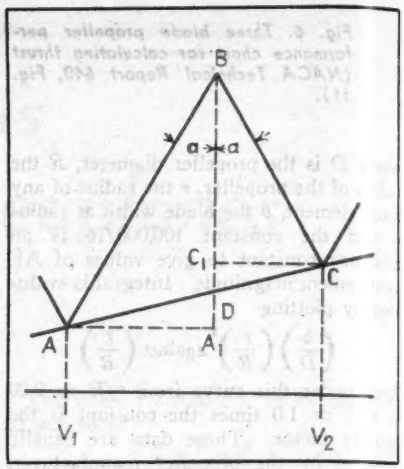


Fig. 9. Elements of Hermann Method

may be obtained either by the use of Simpson's Rule or with a planimeter. The latter is more rapid and to be recommended. In the absence of a planimeter the graphical Hermann Method, outlined later in this article, may be preferred.

Derivation of Modified Method

In the basic takeoff method, previously outlined, the load coefficient C_Δ is reduced in each step by the unloading due to the wing lift. The procedure may be simplified if the wing lift is computed in terms of the hydrodynamic load coefficient, or equivalent C_Δ (referred to δC_Δ), so that it may be subtracted directly from the hull load coefficient C_Δ. In this form, for each step δC_Δ is subtracted from the static load coefficient C_{Δ_o} of equation (22) and the load coefficient C_Δ for the next step in the integration can be determined, without actually computing the wing lift in pounds.

As stated above,

$$\delta C_\Delta = \frac{L}{w\ b^2} \qquad (34)$$

where δC_Δ is the wing lift expressed in hydrodynamic load coefficient form, L

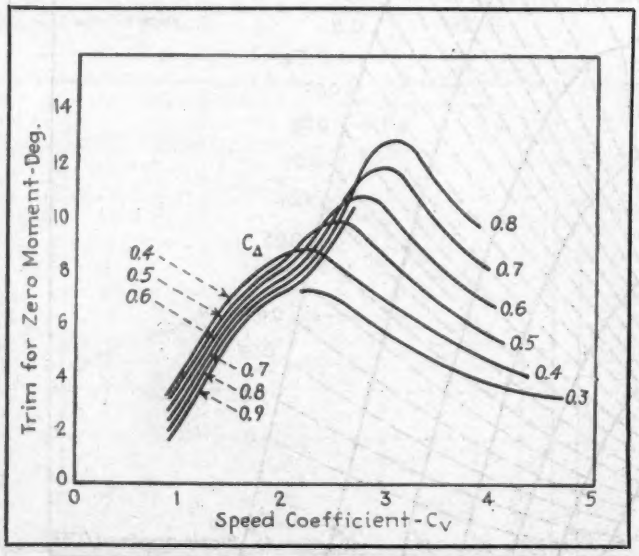


Fig. 10. Variations of trim with speed coefficient for various values of load coefficient—free to trim.

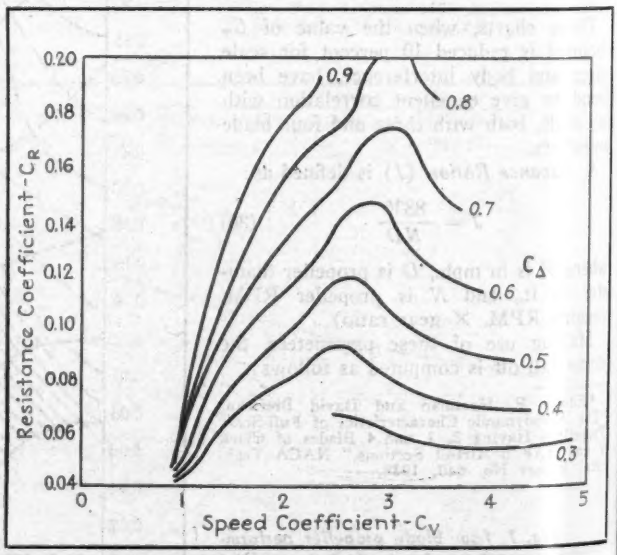


Fig. 11. Variations of hydrodynamic resistance with speed coefficient for various values of load coefficient—free to trim.

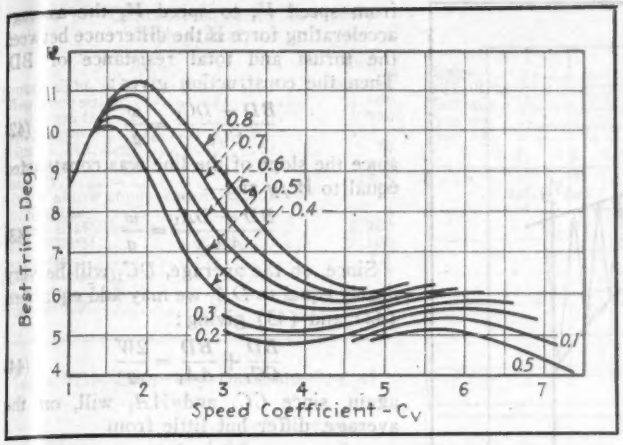


Fig. 12. Variation of trim with speed coefficient for various values of load coefficient—best trim.

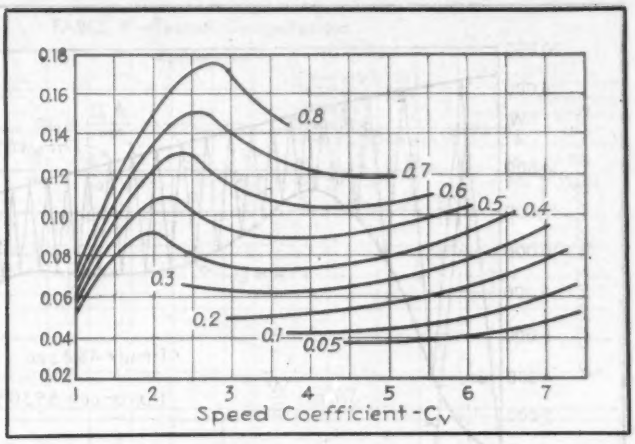


Fig. 13. Variation of hydrodynamic resistance with speed coefficient for various values of load coefficient—best trim.

is the wing lift, lb., w is the density of sea water (64 lb./cu.ft.), and b is the beam, ft.

However,

$$L = \frac{\rho}{2} C_L S V^2 \qquad (35)$$

where ρ is the density of standard air, C_L is the aerodynamic lift coefficient, S is the wing area in sq.ft., and V is the velocity in ft./sec.

Therefore, dividing both sides of equation (35) by wb^3 we have

$$\delta C_\Delta = \frac{L}{wb^3} = \frac{\rho C_L S V^2}{2 \times wb^3} \qquad (36)$$

but by definition,

$$V_{fps} = C_V \times \sqrt{gb} \qquad (37)$$

or,

$$V^2_{fps} = C_V{}^2 gb \qquad (37a)$$

Substituting (37a) in (36),

$$\delta C_\Delta = \frac{L}{wb^3} = \frac{\rho C_L S C_V{}^2 gb}{2 \times wb^3} \qquad (38)$$

clearing terms in (38) we have:

$$\delta C_\Delta = \frac{\rho C_L S C_V{}^2 g}{2 \times wb^2} \qquad (39)$$

collecting and evaluating the constants in equation (39) we have:

ρ = .002378 (standard air)
g = 32.2 ft./sec.^{2}
w = 64 lb./ft.^{3}

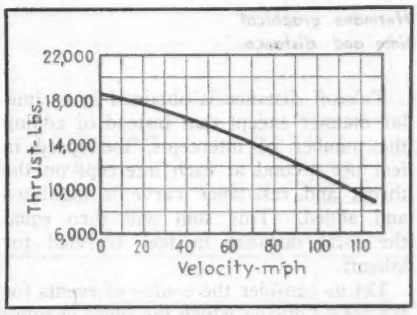


Fig. 14. Variation of thrust with velocity for a typical airplane.

Therefore,

$$\delta C_\Delta = \left(\frac{.002378 \times 32.2}{2 \times 64}\right) \frac{C_L S C_V{}^2}{b^2} \qquad (40)$$

$$\delta C_\Delta = \frac{.0006\, C_L S^2 C_V{}^2}{b^2} \qquad (40a)$$

For any particular analysis, wing area and beam will remain constant throughout the integration, and the constant can be further simplified:

$$\delta C_\Delta = \left(\frac{.0006\, S}{b^2}\right) C_L C_V{}^2 \qquad (41)$$

This method is somewhat shorter than the basic method since computation for wing lift is eliminated. Final results will be identical in either case, the method becoming a matter of personal choice. The data are tabulated in a form similar to Table V on page 137.

Hermann Graphical Method

H. Hermann of DVL in Germany developed an ingenious modification of the classical integration method of determining takeoff time and distance, using a graphical construction on the resistance and thrust curves rather than the integrated areas under the $1/a$ and v/a curves, While this method is not as accurate as the standard method previously described, it is satisfactory in most cases, being particularly helpful where a planimeter is not available for determining the areas of the time and distance curves.

In Fig. 8, the basic construction for the Hermann Method is illustrated. It is identical with the step-by-step integration, except that it is not necessary to determine the colunms—

$$\text{Te}, \frac{1}{a}, \text{or} \frac{v}{a}$$

The construction is started by plotting the values of total resistance $(R + D)$ and total thrust available (T) against velocity in feet per second, as illustrated in Fig. 8. On the pounds axis lay off the point W representing the gross weight

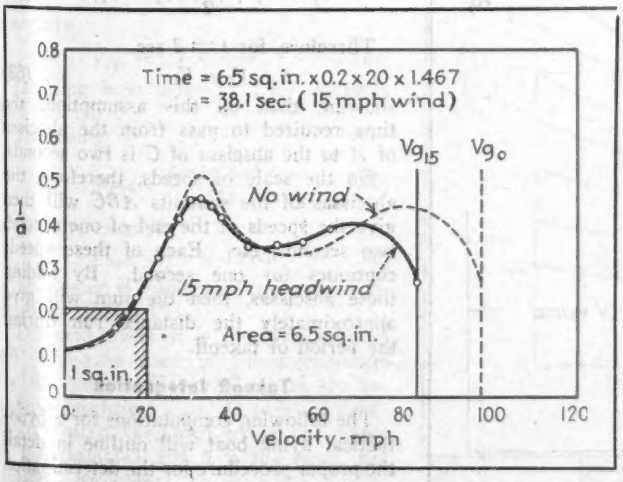


Fig. 15. Curve of 1/a against velocity for graphical integration of takeoff time.

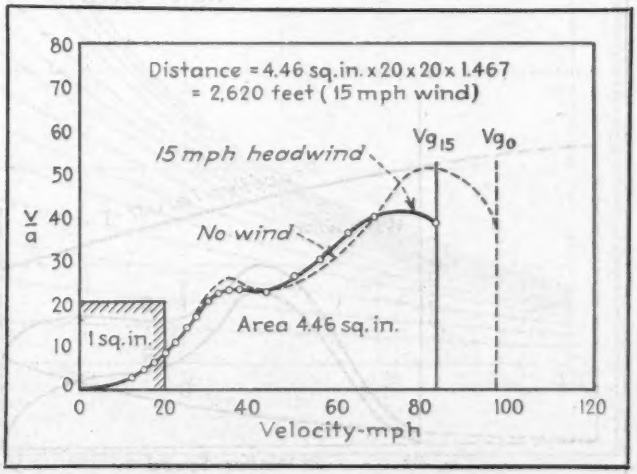


Fig. 16. Curve of v/a against velocity for graphical integration of takeoff distance.

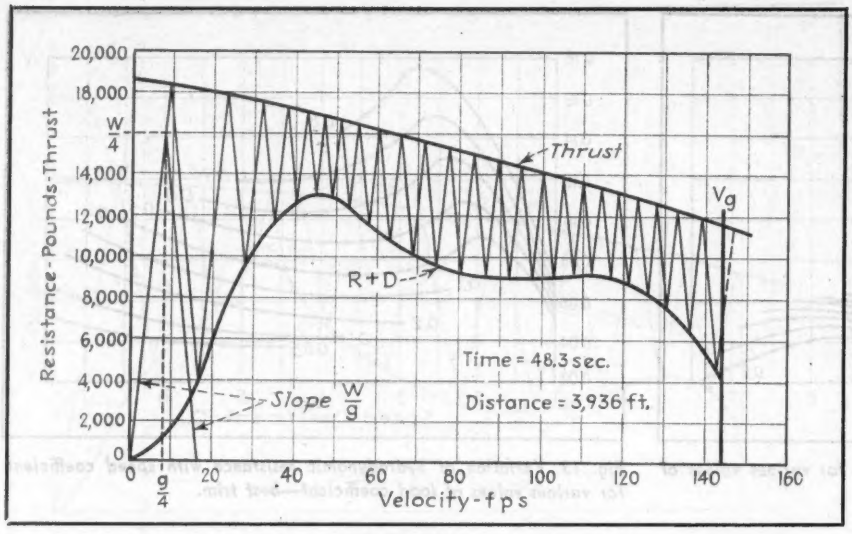


Fig. 17. Example of Hermann graphical solution for takeoff time and distance.

of the airplane. On the speed axis lay off, in feet per second, the point g, or 32.2. From the point determined by these two coordinates, draw a line to the origin which has the slope W/g. From the point of intersection with the upper curve (thrust curve), continue to draw between the two curves a series of intercepts having the same slope as the original line. The number of these intercepts will then equal the number of seconds required for takeoff.

Takeoff distance is obtained in a similar manner except that instead of adding the number of intercepts, the speed in feet per second at each intercept on the thrust and resistance curve is tabulated and added. This sum will then equal the total distance in feet traveled for takeoff.

Let us consider the course of events for the period during which the speed changes from V_1 to V_2, (Fig. 9).

We may assume that in the change from speed V_1 to speed V_2 the average accelerating force is the difference between the thrust and total resistance or BD. Then the construction gives:

$$\frac{BD - DC_1}{CC_1} = \frac{w}{g} \tag{42}$$

since the slope of the line was constructed equal to W/g and—

$$\frac{BD + DA_1}{AA_1} = \frac{w}{g} \tag{43}$$

Since, on the average, DC_1 will be very nearly equal to DA_1 we may add equations (42) and (43) giving:

$$\frac{BD}{CC_1} + \frac{BD}{AA_1} = \frac{2W}{g} \tag{44}$$

again, since CC_1 and AA_1 will, on the average, differ but little from

$$\frac{(V_2 - V_1)}{2}$$

we have:

$$\frac{4BD}{V_2 - V_1} = \frac{2W}{g} \tag{45}$$

Furthermore, the mass of the airplane W/g will move according to the law:

$$S = V_1 t + \frac{1}{2} a t^2 \tag{46}$$

where S is distance and V_1 is initial velocity. Then, from equation (33)

$$a = g \frac{BD}{W} \tag{47}$$

and transposing equation (45)

$$a = g \frac{BD}{W} = \frac{V_2 - V_1}{2} \tag{48}$$

Therefore, substituting in equation (46)

$$S = V_1 t + \frac{1}{4} (V_2 - V_1) t^2 \tag{49}$$

However, from Fig. 9,

$$S = \frac{(V_1 + V^2) t}{2} \tag{50}$$

Substitute final speed V_f for V_2 in equation (50), equate equation (50) to equation (49), and solve for final speed:

$$V_1 + V_f = 2V_1 + \frac{1}{2} (V_2 - V_1) t \tag{51}$$

and

$$V_f = V_1 + \frac{1}{2} (V_2 - V_1) t \tag{52}$$

Therefore, for $t = 2$ sec.

$$V_f = V_1 \tag{53}$$

showing that, on this assumption, the time required to pass from the abscissa of A to the abscissa of C is two seconds.

On the scale of speeds, therefore, the abscissas of the summits ABC will then give the speeds at the end of one second, two seconds, etc. Each of these speeds continues for one second. By adding these abscissas, then the sum will give approximately the distance run during the period of takeoff.

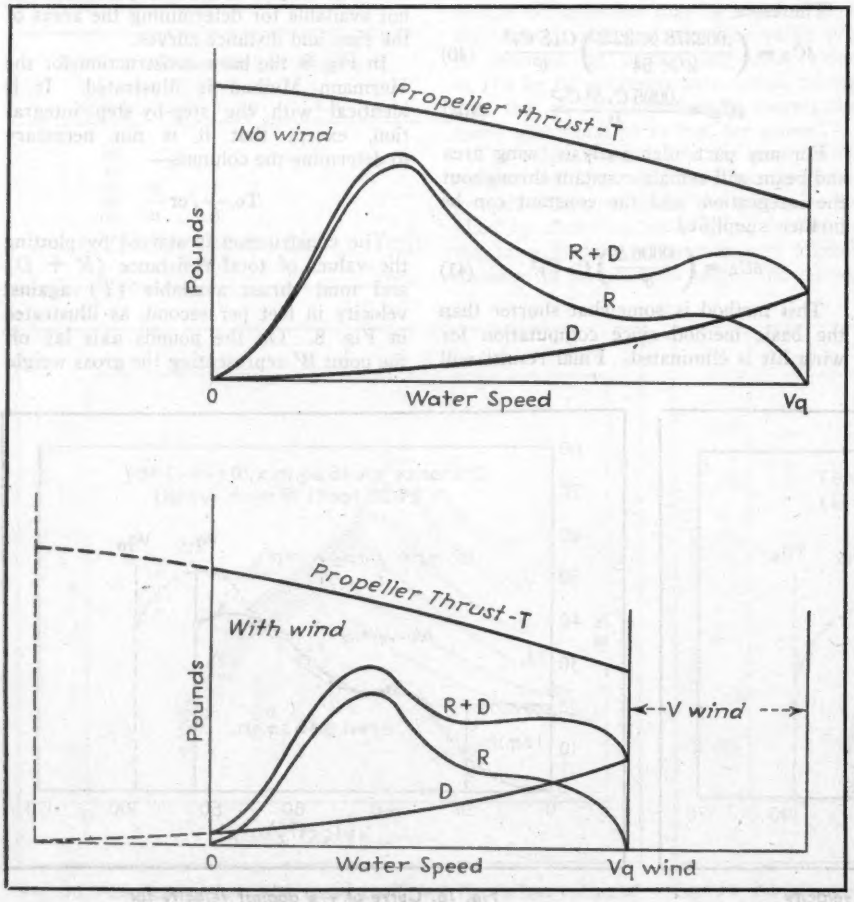


Fig. 18. Influence of a headwind on takeoff diagram.

Takeoff Integration

The following computations for a hypothetical flying boat will outline in detail the proper procedure for the determination of takeoff time and distance.

Table VI lists the characteristics used

Table VI—Characteristics for Exemplary Flying Boat

Item	Given
Gross weight, lb.	64,000
Wing area, sq. ft.	1,600
Wing span, ft.	120
Aspect ratio	9
Flaps @ TO., deg	20
C_L Max.	1.8
Beam, ft.	10.5
h (wing above ground-mean) ft.	11
No. Engines	4
Takeoff BHP/Engine	1,200
Takeoff RPM	2,700
Gear ratio	2:1
Propeller dia., ft.	13
No. blades	3
Propeller AF	90

Table VIII—Exemplary Determination of Thrust

V MPH.	J	C_T	Thrust Lb.
0	0	.143	18,600
20	.10	.136	17,770
40	.20	.125	16,300
60	.30	.114	14,800
80	.40	.102	13,300
100	.50	.089	11,600

in the computations and which must be known before attempting a solution.

The aerodynamic characteristics for the exemplary boat are assumed to be those in Fig. 3 for which the ground effect correction has been computed in Table I. Therefore, all aerodynamic coefficients will be obtained from Fig. 3 using the dashed curves "with ground effect."

Using the standard tabular form illustrated in Table II, the basic airplane characteristics and computation constants are filled in. Table VII (page 273), a complete sample computation based upon the characteristics given in Table VI, will be used to illustrate this example.

The choice of units for velocity is purely arbitrary. It is customary, however, to use either mph. or fps. Regardless of the preference it is essential that consistent units be used throughout the solution. As performance computations using velocity in mph. are usually preferred the example has been set up on that basis.

The first constant to be computed is the factor for converting the speed coefficient C_V to mph. Equation (15) evaluates the speed coefficient as:

$$C_V = \frac{V_{fps}}{\sqrt{gb}}$$

therefore,

$$V_{fps} = C_V \times \sqrt{gb} \qquad (54)$$

Dividing both sides by 1.467 converts fps. to mph.

Therefore,

$$V_{mph} = \frac{C_V \times \sqrt{gb}}{1.467} \qquad (55)$$

or for the example,

$$V_{mph} = C_V \times 12.55 \qquad (56)$$

This value is entered in the space provided in Table VII.

The next constant is the evaluation of wb^3 which is used in the expressions for the load coefficient C_Δ and the resistance coefficient C_R. As w is the density of water (assumed to be sea water in the example) and b is the beam, the constant becomes:

$$64 \times (10.5)^3 = 74{,}090 \qquad (57)$$

TABLE V—Takeoff Computations

Modified Form

Engine : ----------
BHP./RPM. : ----------
Gear ratio : ----------
Prop. dia. : ----------
Prop. AF. : ----------

$C_{\Delta_o} = \frac{\text{G. W.}}{wb^3} = $ ----------

Gross weight, lb. : ----------
Wing area, sq. ft. : ----------
Beam, ft. : ----------
Flaps, deg. : ----------
C_L @ V_s (0.9 C_L max.): ----------

1. C_V	2. V mph.	3. T deg.	4. C_L*	5. δC_Δ	6. C_Δ	7. C_R	8. R lb.	9. C_D*	10. D lb.	11. $R+D$ lb.	12. T lb.	13. T_e lb.	14. $1/a$	15. V_{fps}/a

*Use full ground effect.

$C_V = V_{fps}/\sqrt{gb}$
$C_\Delta = \Delta/wb^2$
$C_R = R/wb^2$

$V_{mps} = C_V \times$ ----------
$\delta C/\Delta = (.0006\ S/b^2)\ C_L C_V^2$
$= C_L C_V^2 \times$ ----------
$C_\Delta = C_{\Delta_o} - \delta C_\Delta$
$=$ ---------- $- \delta C_\Delta$

$R = C_R \times$ ----------
$D = (.0382\Delta S)\ C_D C_V^2$
$= C_D C_V^2 \times$ ----------
$1/a = GW./gT_e =$ ----------$/T_e$

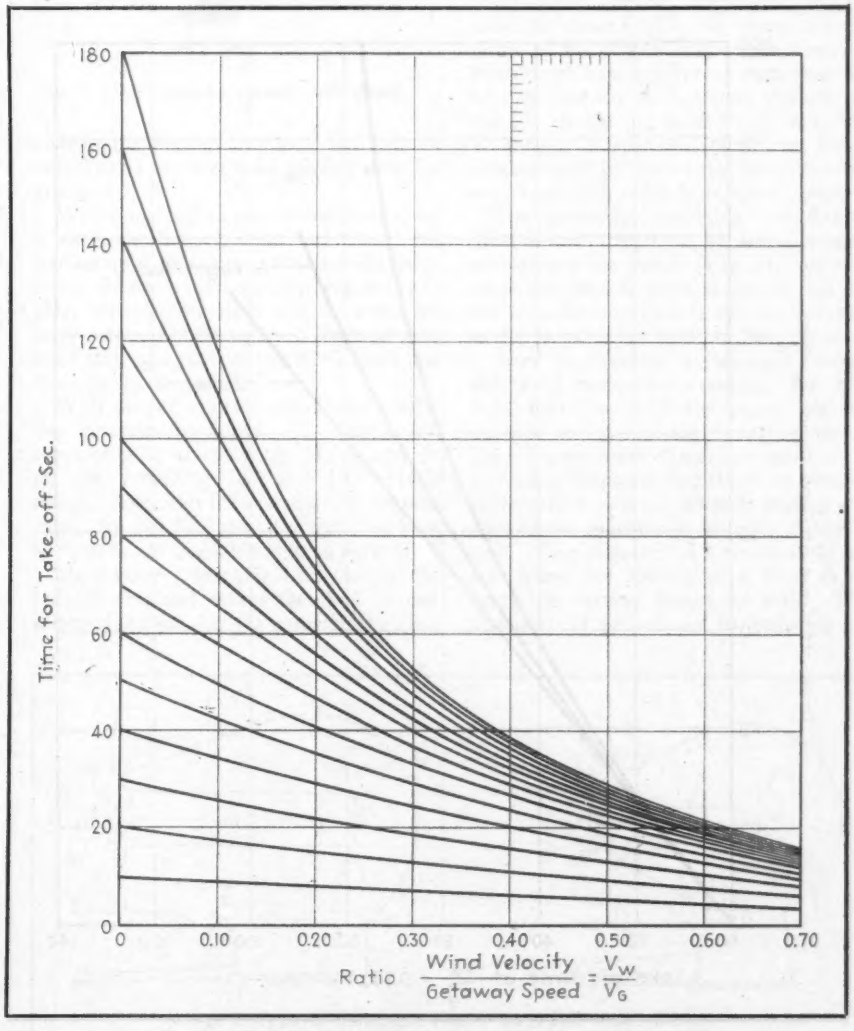


Fig. 19. Graphical representation of effect of wind on take-off time of seaplanes. (Courtesy of The Ronald Press Co.)

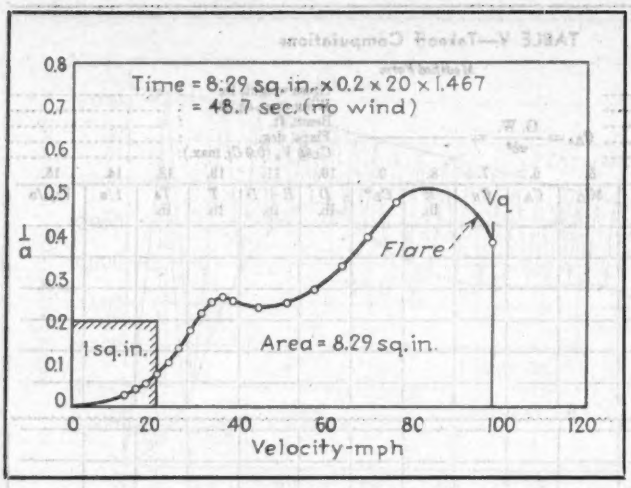


Fig. 20. Effect of 15-mph. headwind on takeoff time integral.

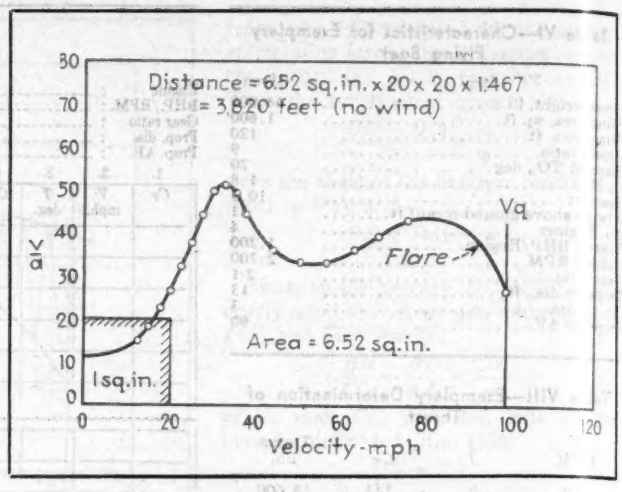


Fig. 21. Effect of 15-mph. headwind on takeoff distance integral.

and this value is entered in the table as the constant for determining both C_Δ and R.

To simplify determination of lift and drag in pounds, a constant is computed. It is wing area S multiplied by the factor .00256, which for the example is:

$$1{,}600 \times .00256 = 4.1 \quad (58)$$

The factor .00256 is the $\rho/2$ of equation (35) multiplied by $(1.467)^2$ which converts v^2 in fps. to mph. if the computations are being based on fps. units for velocity the factor would be simply $\rho/2$ or .001189.

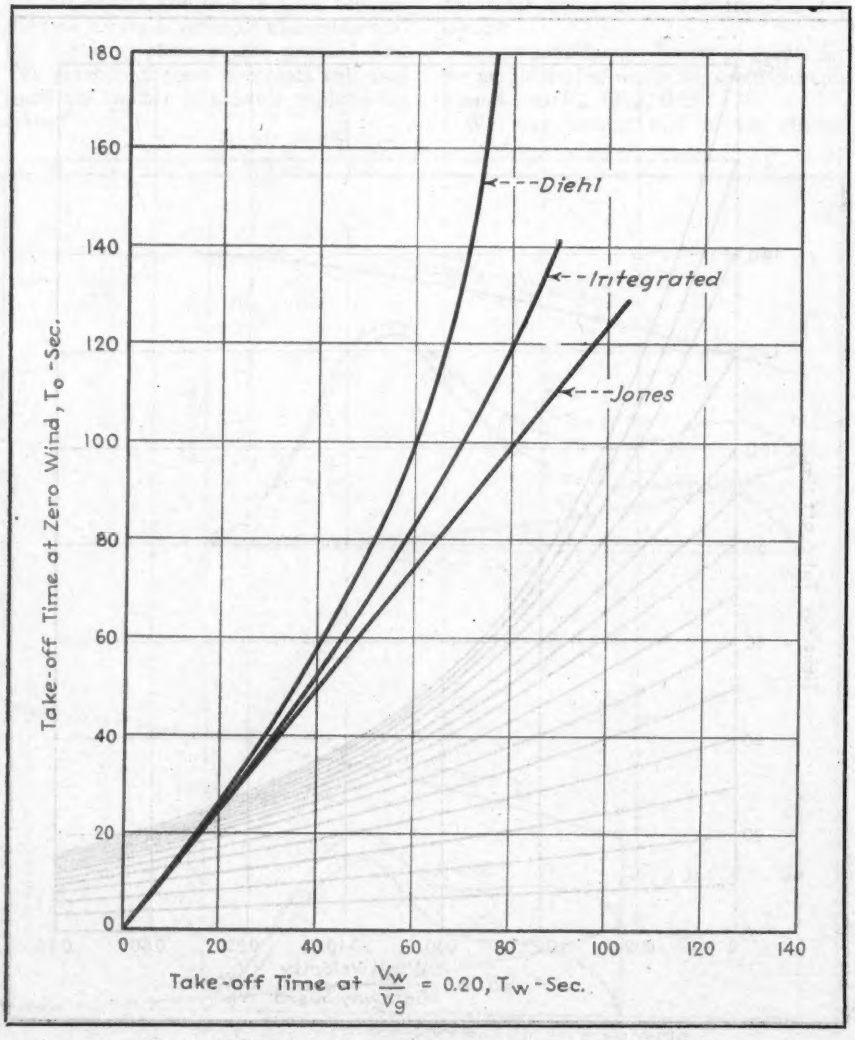


Fig. 22. Variation in wind correction for three standard methods for ratio wind velocity over getaway speed equals 0.20.

The last constant is used in the determination of the reciprocal of the acceleration $1/a$ and is the gross weight divided by the acceleration due to gravity. For the example this constant is:

$$\frac{64{,}000}{32.2} = 1{,}990 \quad (59)$$

The first step in tabulating data is to determine the end point of the integration, which is the getaway speed V_g where the plane becomes airborne. Transposing the expression for lift, equation (35) and using C_L for getaway, the getaway speed in miles per hour may be computed:

$$V_g = \sqrt{\frac{L}{.00256 \times C_{Lg} \times S}} \quad (60)$$

where L, for this condition, is the gross weight in lb., C_{Lg} is 90 percent of the max. C_L (solving for maximum performance), and S is the wing area in sq.ft.

For the example,

$$V_g = \sqrt{\frac{64000}{.00256 \times 1.62 \times 1600}} = 98.2 \text{ mph.} \quad (61)$$

and the corresponding speed coefficient is:

$$C_V = \frac{Vmph.}{12.55} = 7.8 \quad (62)$$

As the flare to getaway is started at least 1.5 C_V prior to actual getaway, the actual step-by-step integration is stopped at $C_V = 6.0$ and the curves are faired from this point to getaway. With end point determined the C_V column (1.) is filled in up to $C_V = 6.0$.

Using the speed coefficient constant at the bottom of Table VII the columns for V (2) and V^2 (3) in mph. are tabulated.

For entering the trim curves, the static load coefficient, C_{Δ_0} is computed and noted in the space provided at the top of Table VII.

Following the procedure outlined previously in this article, the trial and error determination of the trim, τ and load coefficient, C_Δ, is made. These data are tabulated in columns 4. and 8. paying particular attention to the shift from free trim to best trim at the hump. Fig. 10

(*Turn to page 269*)

Automatic Riveting Realizes Manufacturing Economies

By PAUL WISE
Chief Tool & Manufacturing Planning Engineer, The Glenn L. Martin Company

Forethought and the application of a few simple rules could multiply production rates, reduce fabrication costs, and improve quality of work. Here are salient notes on specific tooling methods.

As POINTED OUT in *Aviation* (page 161 July and page 161 August) the use of pierced (punched) holes for rivets, in place of drilled holes, has resulted in marked savings in time, manufacturing cost, space required, and tooling expense at Martin aircraft plants.

Economies are highest when piercing, dimpling, inserting, and heading can be done on a single machine rather than having to drill, countersink and burr holes before riveting with several handling operations between. Airframe designers should consider the possibilities of designs incorporating the conditions for a complete automatic process in order to realize its inherent manufacturing economies.

If the designer starts with the idea of making maximum use of piercing and riveting on one machine, he may be able to adapt some parts to such work where, otherwise, he may inadvertently introduce types of construction that require a much slower and less efficient process. A study of the machine, preferably at work in the shop, will often reveal how even slight changes in the design of the piece can overcome interferences and greatly facilitate assembly with no sacrifice in strength or weight.

The first rule to be observed provides that, *when no dimpling is required, total thickness of two or more parts to be riveted shall not exceed rivet diameter,* because piercing is not feasible with a punch having a diameter less than the depth (length) of the hole (Fig. 1). It follows that rivet diameter should be increased, where conditions permit, if their diameter is less than metal thickness.

When holes are to be dimpled as a part of the machine process, the total thickness of stock should not exceed three-fourths rivet diameter, as additional power is required for dimpling.

Another rule, desirable but sometimes impossible to follow, provides that *all rivets should be of the same size and head type;* since, if fulfilled, the entire job can be done on the same machine. Where the ideal is not attainable *and more than one size or type of rivet is essential, the number of sizes should be kept at the very minimum.*

If more than one length of rivet of the same diameter and head style is used, the corresponding change is quickly accomplished in latest model machines by merely adjusting proper reading for rivet length and filling the hopper and feed with rivets of the new length.

If different head styles of same diameters are used, it is not necessary to change the hopper and feed, but four to seven parts of rivet head tooling must be changed.

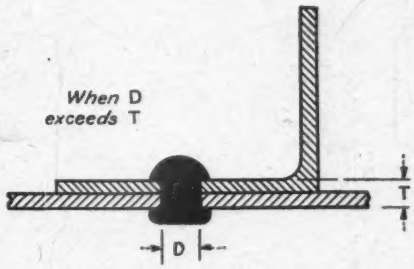


Fig. 1. Rivet diameter exceeds hole depth.

Where more than one diameter of rivet is used, the hopper, feeds and rivet head tooling must be changed for each diameter rivet. If more than one machine is available, considerable time will be saved by setting one machine for each diameter and head style and passing the work from one machine to the other.

With proper tooling, automatic punching riveting machines will handle all types of solid rivets in 3/32, 1/8, 5/32 and 3/16 in. dia. including 78° and 100° Huck rivets. Although it is possible, in certain cases to handle special rivets, special equipment not available may be needed.

To employ a machine that pierces the hole, inserts and drives the rivet in one setting *requires that the assembly be such that the parts can be brought into the correct position relative to the machine.* The parts and fixtures required for holding them must clear the machine and tools used in it. Thus, for example, the rivet must not be so far from the nearest edge of the piece that the piece will foul the throat (Fig. 2).

Moreover, the die holder and stripper must be cleared, (Fig. 3) hence the distance of the center of the hole from the nearest wall on projecting part must not be such that the die holder or stripper are fouled. If the die holder does not clear a flange, a special length die button measuring 9/16" under the die holder will overcome such obstacle in many cases.

The assembly, including the fixture, must be such that it can be passed between the die and the punch (Fig. 3). In most machines, this distance is 1¼ or 1½ in., but in some machines it can be increased to 4½ in. with the anvil support down.

Since the question of clearance involves ability to bring the assembly, for each hole, into line with the punch and die centers, it follows that *part should be "open" ones with flange or wall to be pierced so disposed that it can be brought into correct position without fouling any part of the machine or another flange or wall.* The diameter of stripper is 5/8 in., permitting the placing of a rivet 7/16 in. from the vertical flange or wall. This distance can be reduced by reducing the

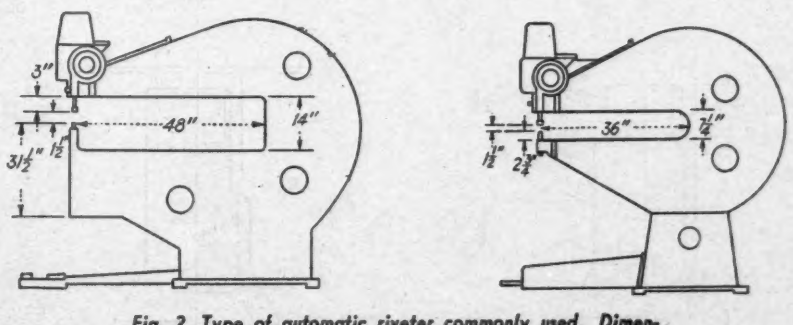


Fig. 2. Type of automatic riveter commonly used. Dimensions show limitations to which assembly must conform.

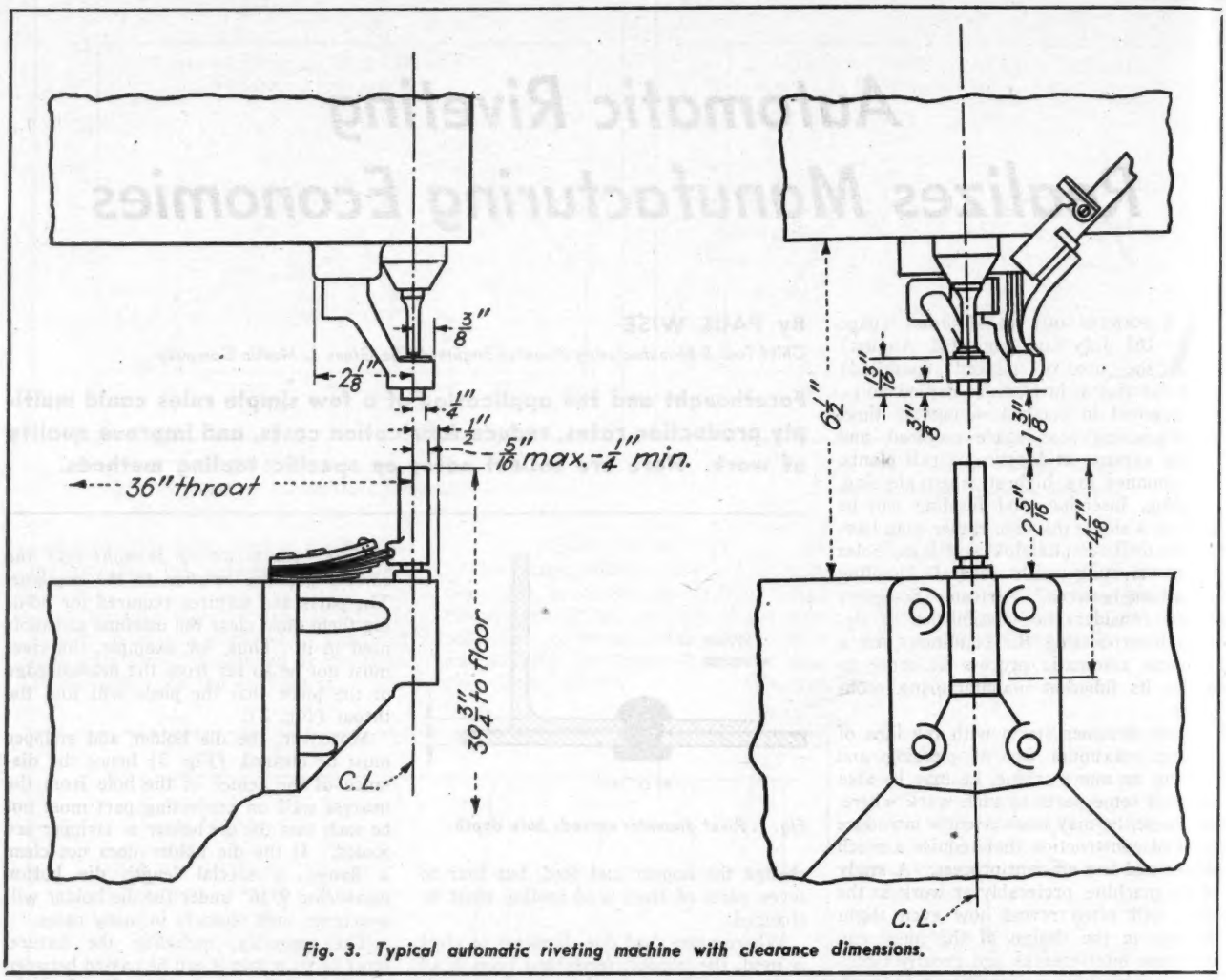


Fig. 3. Typical automatic riveting machine with clearance dimensions.

diameter of stripper to ½ in. for a distance of ½ in. from top of stripper as in Fig. 4A, or a flat can be ground on one or more sides of the stripper to reduce distance between flange and center of punched hole, Fig. 4B. Where the bulb on angle or a Z-section prevents centering the hole in flange section, this can be overcome by grinding out the stripper and anvil post for proper clearance, so long as such grinding does not reach the punch, as in Fig. 4C. In using the automatic machine dealt with here, it is not usually feasible to apply rivets through one short leg of a channel because the opposite short leg interferes, but where the space between legs is 3½ in. min., the arrangement shown in Fig. 5 has been used.

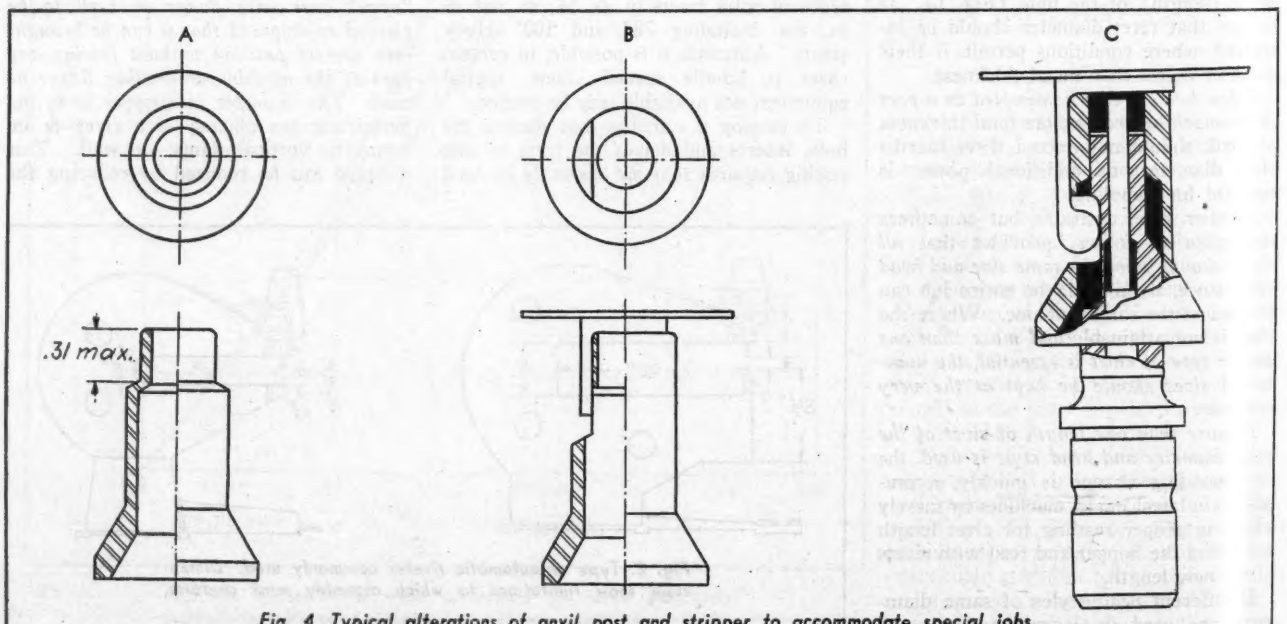


Fig. 4. Typical alterations of anvil post and stripper to accommodate special jobs.

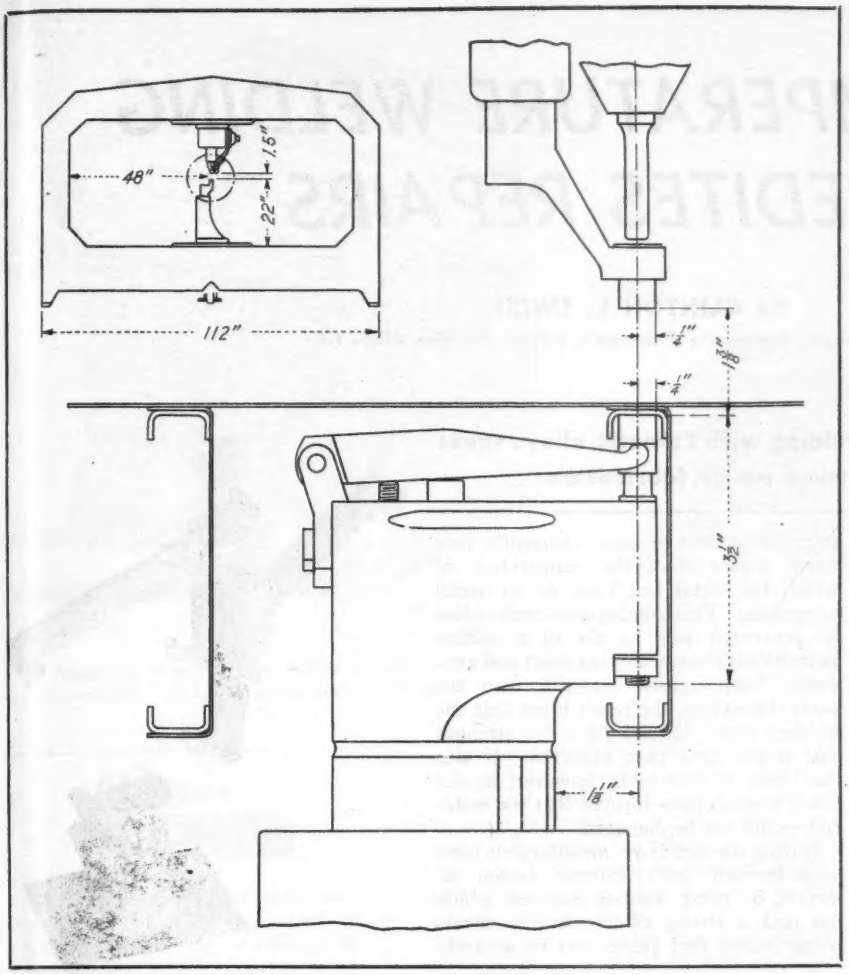


Fig. 5. Machine riveter with special head for tight work.

Where clearances are tight, the special horn shown in Fig. 5 has proved useful. Where close angles are necessary, it is better to have the angle below (next to stripper) than above the sheet, as then possible machine or work injury is avoided.

Experience has shown that some quite deep sections can be wholly or partly handled on the machine with great savings in time over hand drilling and hand tools for setting rivets. Even such deep sections as leading edge sections for wings have been riveted with high economy although the formed sheets had to be sprung apart slightly during parts of the riveting process, Fig. 6.

To realize the maximum possible economies from automatic riveting, it is necessary to *plan the work so that riveting on sub-assemblies is as nearly complete as possible before they are built into the ship.*

Skins up to 8 ft. in width and of any length can be handled if proper supports are provided. Relatively flat skin panels having long rows of rivets through straight stringers are ideal for automatic riveting and generally make possible the maximum economy. Nevertheless, many large units are pierced and riveted, even by a single operator, when spring or equivalent supports are provided and, even large corrugated panels can be passed through automatic machines.

One advantage of machine piercing and riveting is that tooling is greatly simplified. Expensive drilling jigs and fixtures are dispensed with and, where positive hole location is required, a light-and inexpensive fixture of phenol fibre of Masonite meets all requirements. Such a fixture is commonly made to nest the parts in slots or against stops, so that spring

(*Turn to page 263*)

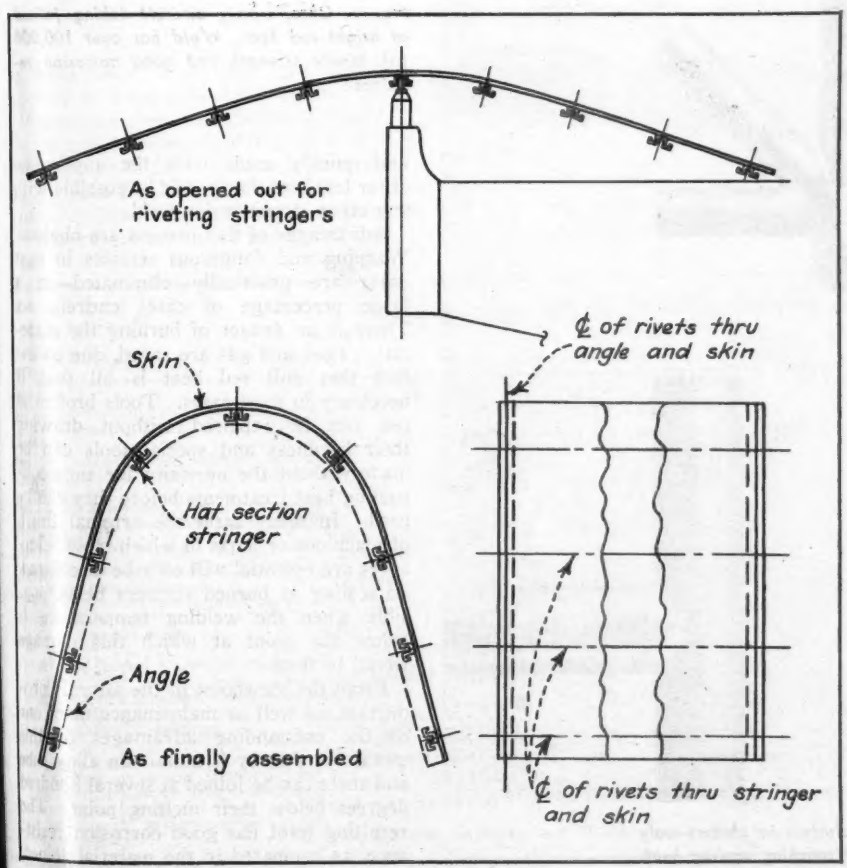

As opened out for riveting stringers
℄ of rivets thru angle and skin
Skin
Hat section stringer
Angle
As finally assembled
℄ of rivets thru stringer and skin

Fig. 6. Leading edge as opened out after forming for riveting stringers to skin, and as finally assembled with angles riveted to ends.

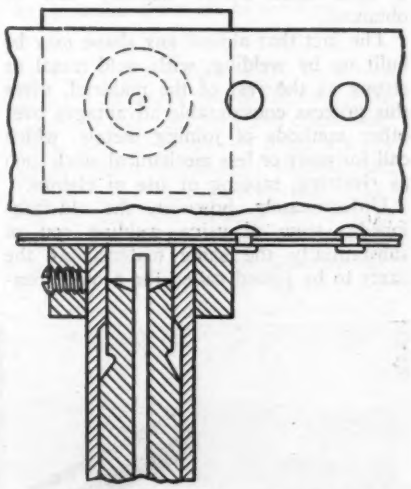


Fig. 7. Application of spacer block over stripper to facilitate uniform hole location.

LOW TEMPERATURE WELDING EXPEDITES REPAIRS

By CLINTON L. SWIFT

Assistant Manager, Engineering & Research, Eutectic Welding Alloys Co.

Low melting point, high strength welding with Eutectic alloys saves gas and time, frequently permits much easier fabrication.

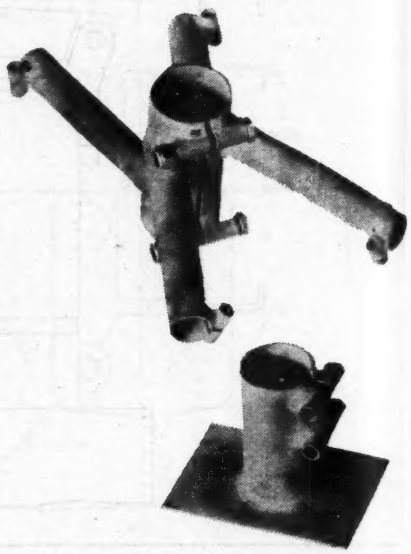


Fig. 1. Chrome-moly aircraft tubing joined at bright red heat. Weld has over 100,000 psi. tensile strength and good corrosion resistance.

WELDING, as a method of fabricating tools and fixtures for maintenance, is one of the mainstays of the man who, in these days of shortages, must either make what he wants or wait a long time before delivery can be obtained.

The fact that almost any shape may be built up by welding, with weld metal as strong as the rest of the material, gives this process considerable advantages over other methods of joining metals, which call for more or less mechanical work such as rivetting, tapping or use of clamps.

Unfortunately, however, the old-fashioned system of using welding rod of substantially the same material as the parts to be joined called for a quite considerable amount of heat—frequently very much higher than the temperature at which the metal lost some of its useful properties. This contingency could often be prevented only by use of a joining material with lower melting point and generally lesser tensile strength than the parts themselves, the result being that the finished work did not have the strength that might have been expected. It was the lesser of two evils, however, as the lower temperatures insured that the material would not be damaged.

During the last 25 yr. metallurgists have experimented with eutectic fusion of metals, by using welding material which has such a strong affinity for the metals being joined that joints can be securely and quickly made with the application of far less heat than would be possible with any other strong fusion weld.

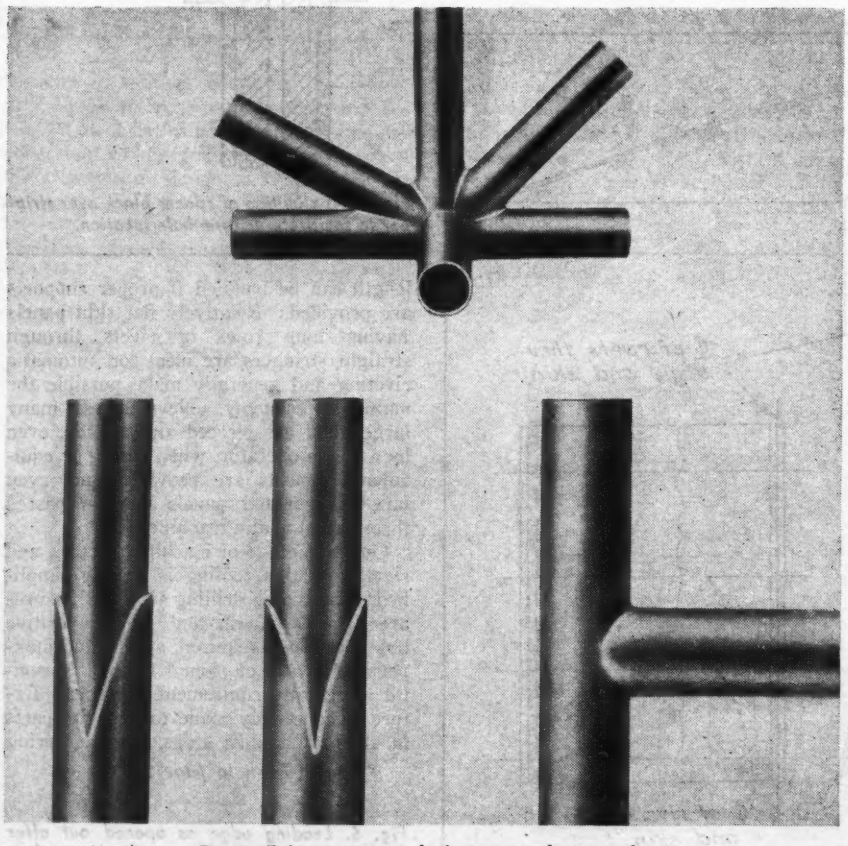


Fig. 2. Tubing joints and clusters in chrome-moly steel can be joined without reaching scaling heat.

Advantages of this process are obvious. Warping and dangerous stresses in cast parts are practically eliminated—in a large percentage of cases entirely so. There is no danger of burning the material. Time and gas are saved, due to the fact that dull red heat is all that is necessary in most cases. Tools broken in use can be repaired without drawing their hardness and special tools can be made without the necessity for time-consuming heat treatments before they can be used. In many cases the original finish of machines or parts in which close tolerances are essential will only be discolored, no scaling or burned surfaces being possible when the welding temperature is below the point at which this damage would be done.

From the viewpoint of the aircraft production, as well as maintenance man, one of the outstanding advantages of this method is that by it aluminum alloy tube and sheet can be joined at several hundred degrees below their melting point. The resulting joint has good corrosion resistance, as compared to the material joined,

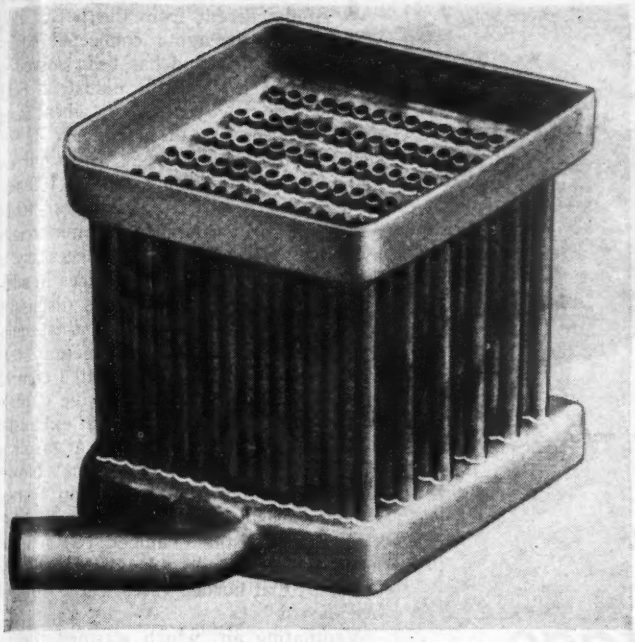


Fig. 3. Aluminum alloy radiator welded at 200 deg. below melting point of material. Tensile strength about 30,000 psi.

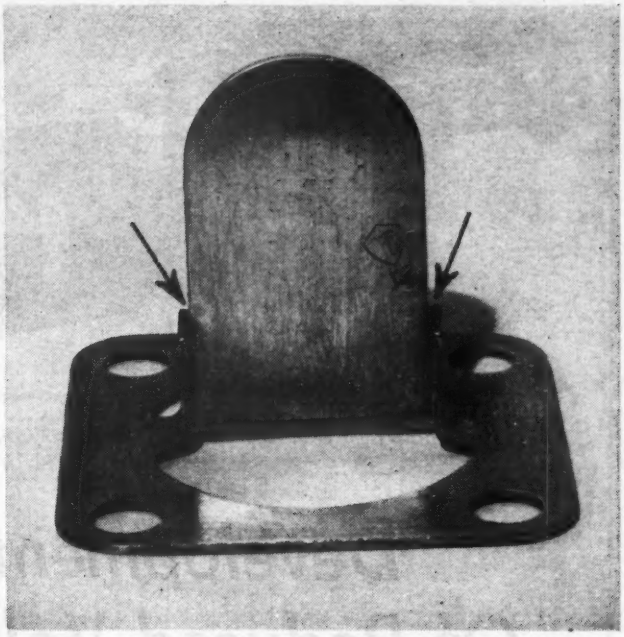


Fig. 5. Aluminum alloy bracket welded at 1,000 deg. Has 30,000 psi. tensile strength and has not lost hardness. Weld can be anodized.

Fig. 4. Beryllium copper radio connector less than 1 in. long joined at 950 deg. F. Heat was not sufficient to draw hardness.

the joint itself is invisible and can be anodized with the rest of the finished job.

Magnesium sheet and castings are weldable in this manner, resulting in a weld having about 29,000 psi. tensile strength and a Brinnell hardness of over 50.

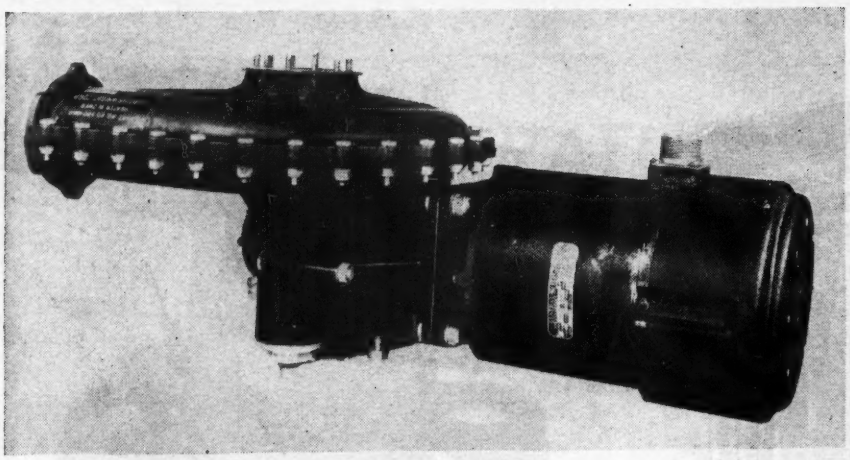
Another use for the process is building up of worn surfaces. At a dull red heat Eutectic alloys can be applied for building surfaces with a bronze having a Brinnell hardness of around 200 and a remelting point of 1,750 deg.F. This high remelting point is a feature of Eutectic welding alloys and offers great advantages where finished or repaired parts will be exposed to heat while in use.

Used with a flux specially compounded for each metal to be joined, the thin-flowing Eutectic welding alloys flow completely through butt and lap joints, in many cases making unnecessary expensive chamfering of edges before welding. As the welding rod runs into and completely fills the joint, large outside fillets are not required unless mechanical design calls for them. For the same reason, application of heat and welding rod is only necessary on one side of any but the heaviest work, thus effecting considerable savings and often permitting repairs to be made without expensive dismantling of surrounding parts.

Fig. 6. Broken twist drill welded at low temperature did not lose hardness or strength. Scaling temperature was not reached.

Table I—Properties of Eutectic Welding Alloys

Material welded	type of work	temp. deg. F.	remelts deg. F.	Tensile strength	Brinnell hardness	color match	corrosion resistance	Welding rod composition
Cast iron	all	950–1,400	2,250	50,000	200–220	invisible	very good	Ferrous
Steel, chrome-moly, stainless, maganese, C. I., bronze, brass, copper, nickel, monel	all	1,300–1,600	1,750–1,800	80,000–150,000	160–170	close	good	Copper base
Steel to bronze, brass, copper, cast & malleable iron, stainless steel, nickel, monel	all	940–1,120	1,120	53,000	75–85	differs	good	Copper base
C. I. to all steels and non-ferrous except brass, aluminum, magnesium, die-castings	all except light gage	Arc	2,300	30,000	200–225	invisible	good	Nickel alloy
Copper, bronze and brass	all	1290–1,350	1,290	38,000	140–170	visible	good	Copper base
Copper, bronze and brass	light & med.	1,200–1,300	1,500	45,000	80–90	visible	good	Copper base
Copper, bronze & brass to cast iron, steel, monel	all	940–1,120	1,120	53,000	75–85	visible	good	Copper base
Nickel and nickel alloys	all except elect.	1,290–1,600	1,800	95,000	140–150	close	good	Nickel alloy
Nickel and nickel alloys to steels and bronzes	med. & heavy	1,000–1,200	1,240	58,000	85	close	good	Copper base
Aluminum and alloy sheet, steels, bronzes and nickel	all	950–1,060	1,100	30,000	55–65	invisible	very good	Aluminum base
Aluminum sheet & castings	light & med.	950–1,020	1,100	29,000	70–85	invisible	good	Aluminum base
Magnesium	all	960–1,060	1,200	29,000	50–60	invisible	very good	Magnesium base
Die castings, zinc base	light & med.	700–800	780	28,000	40–50	invisible	very good	Zinc base
For building up against frictional wear, cast iron, malleable iron, stainless & manganese steel, monel	med. & heavy	1,000	1,750	80,000	180–235	visible	very good	Copper base
For building up against abrasive wear, manganese steel	med. & heavy	sweating heat	2,400	50,000	450–500	invisible	good	Ferrous



Curtiss-Wright centrifugal heater blower with 2¼ hp. motor.

Development Of Reduced Voltage Motor Controllers

By JAMES F. CARLAND, *Industrial control specialist, General Electric Co., and* **P. R. WATSON,** *Curtiss-Wright Corp.*

Transition stages of aircraft electric motor starters from the simple hand control type to compact automatic devices which relieve the pilot of much tedious detail.

THE PROBLEM of starting an electric motor without requiring unduly high current from the power line, and without damaging connected equipment, is not new and has been solved in a number of ways in the industrial field. However, a few years ago, when faced with the necessity of starting a 1½ hp. series motor, with its high inrush current and high torque, from a 28.5-v. 100-amp system; one aircraft manufacturer found no applicable equipment commercially available. Therefore it was necessary to develop sources of control devices in addition to control schemes. This discussion will trace the development of this equipment from its earliest experimental stage to a refined design of coordinated control.

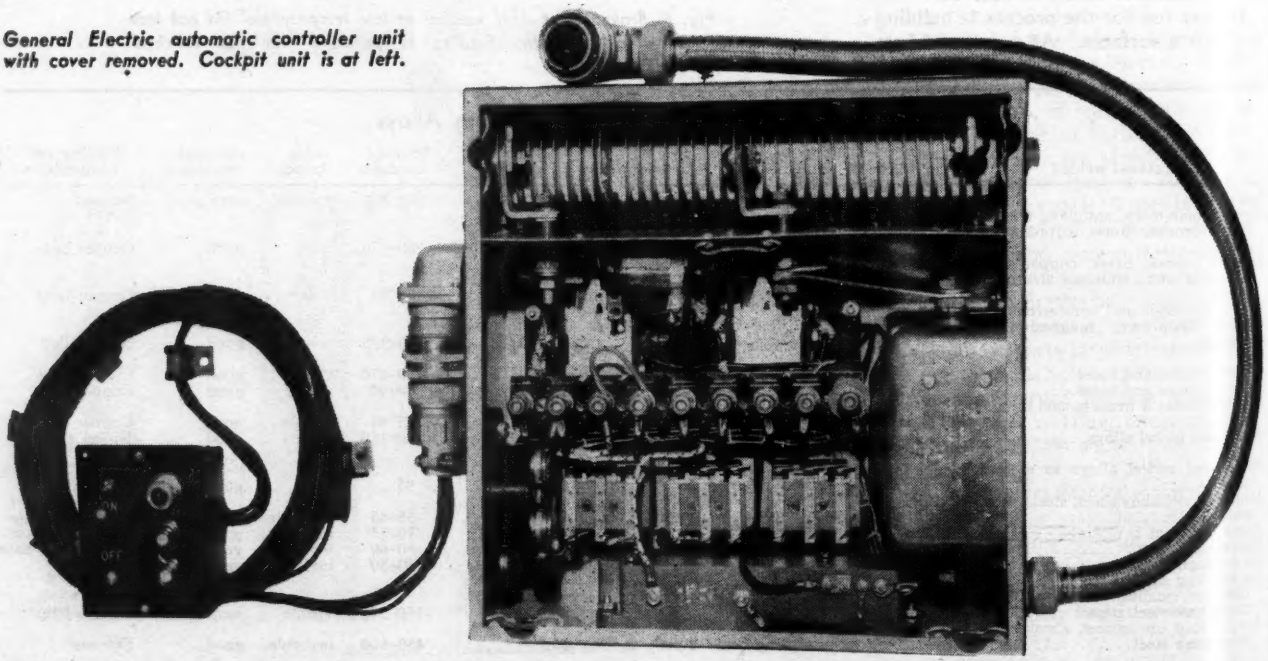
This motor was used to drive a high-speed centrifugal blower which exhausted products of combustion from a gasoline-burning airplane heater. The blower drew air through the combustion system, which consisted of: (1) the carburetor, (2) the combustion chamber, (3) a finned heat-exchanger, and (4) the blower, so arranged that burned gases were "dumped over-board."

Ventilating air, which warmed the inside of the airplane, entered through a vent in the leading edge of a wing or in the nose, and was driven by ram pressure as the airplane passed through the atmosphere. Ducts carried this air to the heater, directing it over and around the finned heat-exchanger. The hot air was then carried into the pilot's cabin, passenger space, and cargo compartments, finally leaving the airplane through vents and openings in the skin.

The blower impeller for combustion air was a small, centrifugal device driven at approximately 27,000 rpm. by a 5,800-rpm. motor, using a 4¾-to-1 step-up gear. Certain considerations in the performance of the blower dictated the use of a series motor.

A 1½ hp. motor was used on the initial

General Electric automatic controller unit with cover removed. Cockpit unit is at left.



heater installation, but the motor size was changed to 2½ hp. on subsequent airplanes. The blower was lubricated by a small centrifugal oil pump on the end of the low speed (5.800-rpm.) motor shaft.

Tests on the 1½ hp. motor used in the initial installation disclosed that the initial inrush at normal airplane voltage was between 500 and 700 amp. Since an appreciable length of time was required to bring the motor up to speed, the high current, with consequent low voltage on the airplane system, would have an undesirable effect on other equipment.

Therefore, a system of reduced voltage starting was devised. Manual control was used for simplicity and to save weight. The control was arranged so that a contactor first closed a motor circuit through a resistance which limited the starting current. After the motor had accelerated to a point when an oil pressure switch (actuated by the oil pump in the lubricating system) closed, another contactor would close, short-circuiting the starting resistance and energizing the motor at full voltage.

Other control requirements were: (1) If the oil pressure failed or excessive temperature occurred in the ventilating system, motor, fuel pump, and ignition coils would shut down. (2) ignition coils could not be energized until motor was running.

A schematic wiring diagram is shown in Fig.1. Control consisted of a switchboard in the pilot's compartment and the various contactors, relays, and fuses mounted individually in the main electrical junction box. On the pilot's switchboard were mounted a double-pole, double-throw momentary contact toggle switch, a *stop* push-button, and two indicating lights.

Power was supplied to control circuits through a circuit breaker in the overhead panel. The junction box contained two auxiliary relays, *start* and *run* contactor rated 100 amp., wire-wound starting resistor, main power fuse, and terminal block for connections; also battery solenoids, inverter switches, fuses, and other miscellaneous electrical apparatus. Thermostats, ignition coils, and fuel pump were mounted on or near the heater.

Operation of Manual System

To start the heater, the pilot closes the circuit breaker in the overhead panel, energizing the control circuits, then pushes the manual double-throw switch (Fig. 1)

(*Turn to page* 264)

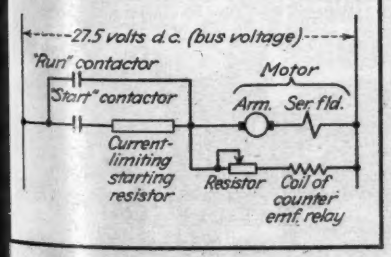


Fig. 2. Schematic diagram of application of counter-emf. relay.

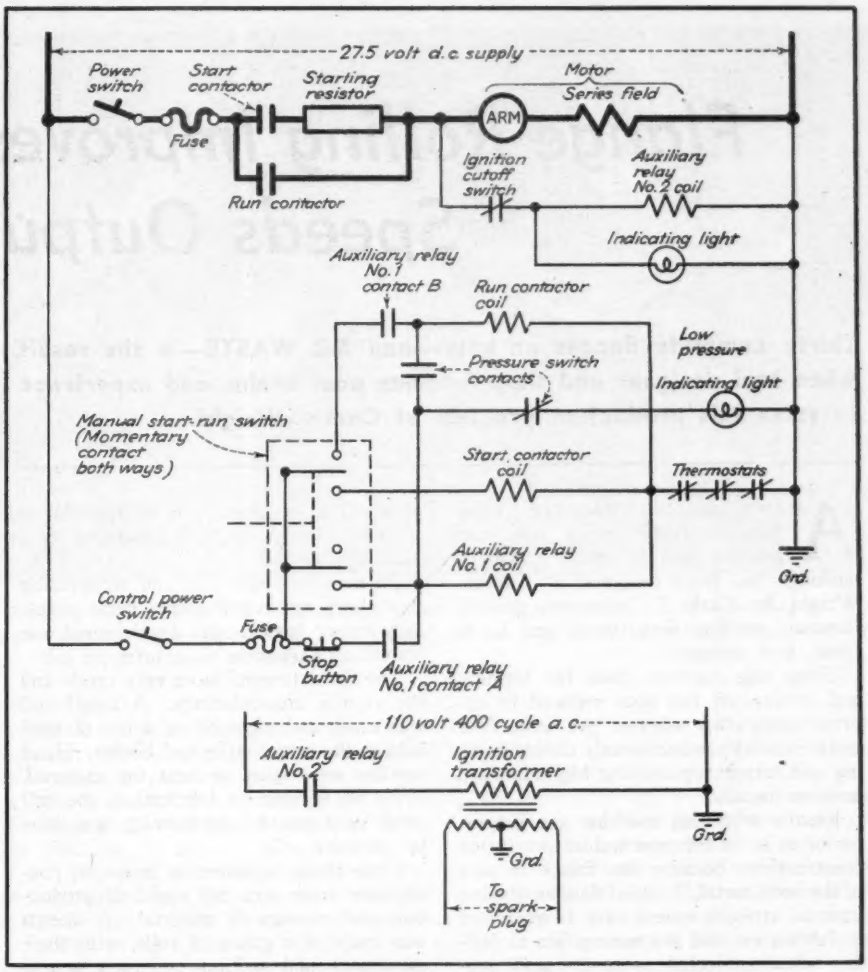


Fig. 1. Schematic diagram of manual control.

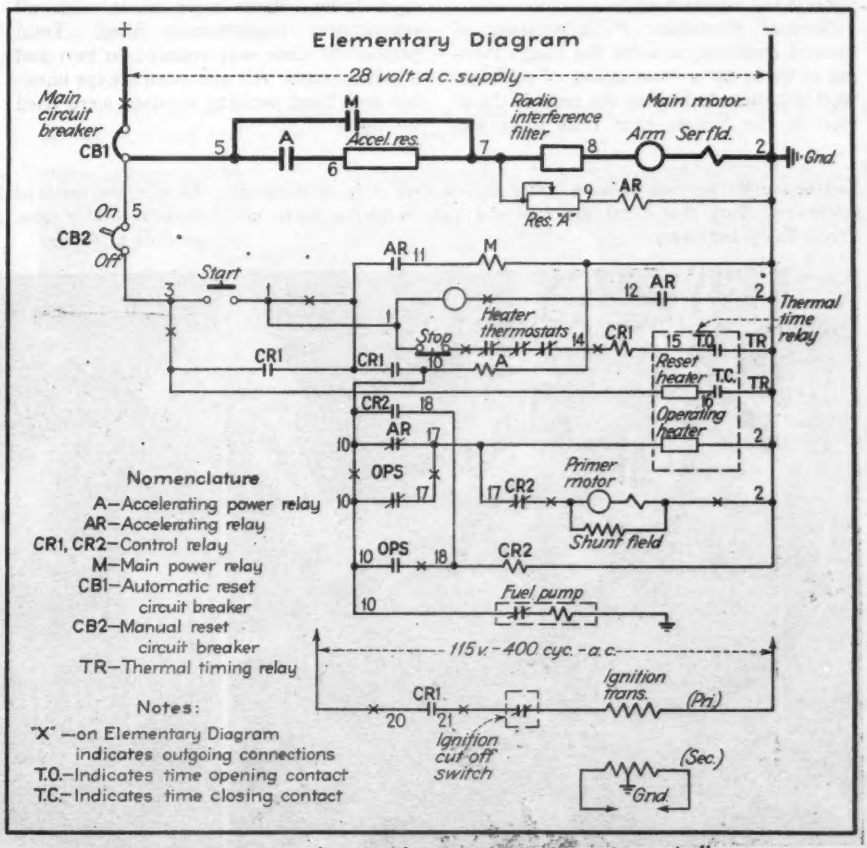


Fig. 3. Elementary diagram of automatic starting motor controller.

Flange Rolling Improves Quality, Speeds Output

Thirty complete flanges an hour—and NO WASTE—is the result when tool designer and shop foreman pool brains and experience to solve this production problem at Curtiss-Wright.

A FLANGE ROLLING MACHINE, using backing and forming rolls and heating unit for making flanged bushings has been designed at Curtiss-Wright by Earle F. Lohmann, general foreman, welding department, and L. S. Lyon, tool designer.

Using this machine, time for forming and cutting off has been reduced to approximately two minutes per unit. The metal is worked continuously during heating and forming, producing high standard uniform results.

Results with this machine are far superior to more common welded or riveted constructions because the flange is part of the body metal. Welded flanges develop internal stresses unless care is exercised in fabrication and are susceptible to failure when subjected to severe and prolonged vibration. Riveted flanges are objectionable because of weight and the uncertainty of riveting.

Normal procedure in fabrication of flanged bushings calls for the rough turning of these parts from tubing of sufficient wall thickness to include the outside diameter of the flange, then heat treat and grind. The resultant loss of material is tremendous and has been regarded as a necessary evil.

To overcome this loss and recognizing that short run requirements made necessary a very flexible unit, development was started on a machine to perform the job.

The first attempts were very crude and the results unsatisfactory. A small roll was made and mounted on a bar of steel held in the turret lathe tool holder. Hand torches were used to heat the material. With no cooling or lubrication, the roll stuck very quickly and forming was done by pressure only.

From these experiments, however, possibilities were seen for speed of production and savings in material. A sketch was made of a group of rolls, with their movements and positions necessary to produce a completed flange. Following this, a hand operated unit was built and set up in a lathe. Parts were made with all engineering requirements filled. Total production time was reduced to two and a half minutes. All movements were hand-fed and hand welding torches were used for heat.

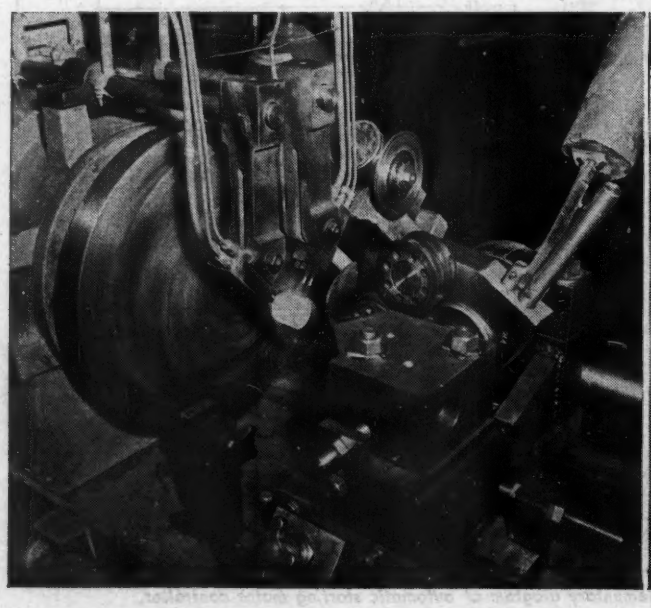
Through experience gained with this machine, a more elaborate device was developed, with self-contained heating unit, cutoff tool and faster action. Designed for flexibility in many different applications, it produced uniform results.

The capacity of the machine in forming tubing ranges from one inch by .035 wall to 3½ in. by .250 wall and the tubing can be flanged on both ends. By the use of special jaws, tubing of 6-in. dia. and .250 wall can be flanged on one end only. The machine can be used without revolving the head and has been used very successfully in heading bolts. Equipment to do this is simple and requires no change of any consequence. Uses can be extended to the manufacture of double integral and central flanges, also external and internal upsetting. The device has already demonstrated its value on production runs with high productivity and great savings in material.

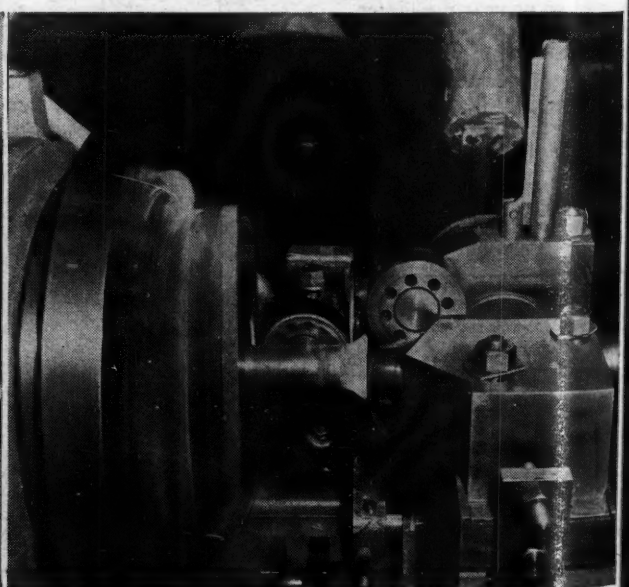
The flange rolling method consists in heating the metal until it has attained a plastic state, following this immediately by a series of press operations. During the process the metal is rotated so that it is worked uniformly and is supported by backing rolls, which control the flange formation. A series of forming rolls completes the steps so that the metal may be made any desired shape.

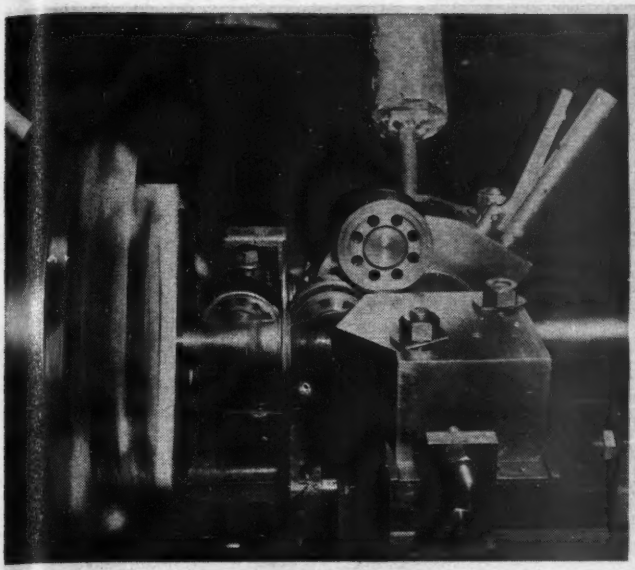
The machine is mounted on an eight-foot I-beam with the web horizontal. At

Self acting torches heat tube to 1,400 deg. in first stage of flanging operation. Note that chuck and tube are only revolving parts, all others being stationary.

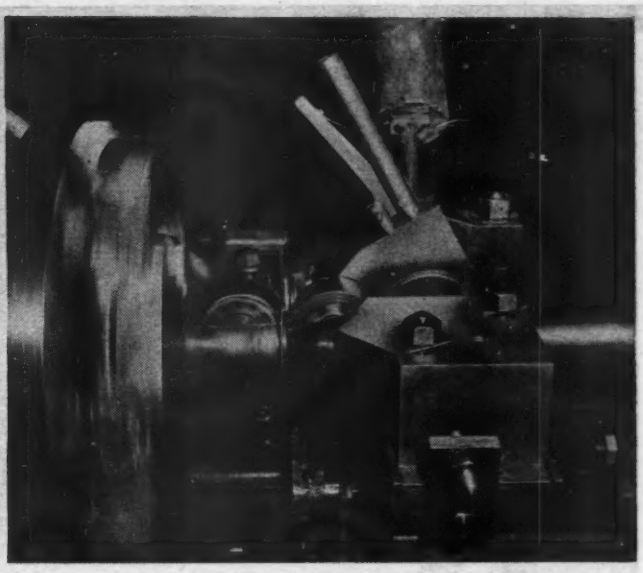


Torches are removed in second step of flanging and tapered roller flares revolving tube. Backing roll acts as steady rest and determines position of flange.





While tube is still being flared by conical roller, turning roll (right one of revolving pair) flattens and contours the flange, which is still at red heat.



Final shaping stage. Turning roll replaced by flat finishing roll with thin control blade roll bringing outside flange diameter to correct dimensions.

one end of the web is a heavy cast iron head carrying a spindle in two large roller bearings. This tube has an inside diameter of 6½ in. and the housing projects from one end to receive a chuck, and at the other, a work centering mechanism. This chuck and steady rest both open to admit 6½ in. dia. Spindle drive is a U.S. variable speed of three hp. with range from 100 to 400 rpm.

An adjustable heating unit of large capacity is connected with the hydraulic mechanism so that it automatically moves into position, is turned on and lighted.

A material feed has been provided, with stops so that when the chuck is stationary, a quarter turn of a handle allows material to be fed against a stop after which the chuck is closed.

The forming rolls are actuated by hydraulic pressure supplied by a pump mounted under the bed of the machine.

The back-up and flange limiting rolls are carried on an arm that pivots on the back of the bed. These rolls are operated by moving a lever placed conveniently on the side nearest the operator. The heating unit and a shutoff valve are operated by the same movement. As the lever is pulled toward the operator, the back-up roll moves clear of the work and the torch moves into position, is turned on and ignited. When the material is hot enough, the heating unit is moved away and turned off by the action of the back-up roll moving into position.

Forming rolls are carried on a bed which moves in gibs and are powered by another hydraulic cylinder, the control for which is close to the other valve lever.

Rolls, set up to produce a given flange, are brought into contact with the plastic material with sufficient force to produce the finished part while the material is still hot. Carbide tipped cutoff tools are used whereby the flange can be cut to length while red hot.

The tube is centered and clamped in the chuck, with the metal stock projecting from the face just sufficiently for forming, the remainder being in the spindle. The portion to be formed is then heated by the burners until a temperature above 1,400 deg. F. is reached, and kept uniform by rotating the tube.

The heat is turned off and the back-up roll is brought into a position back of the tube end. This back-up or supporting roll, on an adjustable carriage, has an axis perpendicular to that of the tube.

Immediately, a conical shaped expanding roll is pressed into the tube, in contact with the inside, the other side of the roll bending over the material at a point opposite the point of contact between the back-up roll and the outside of the tube.

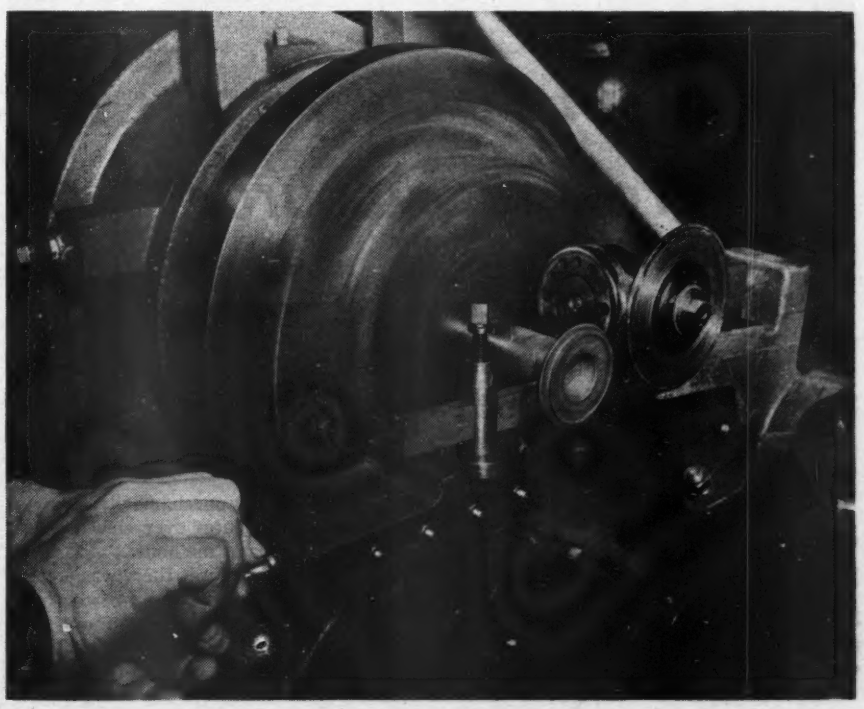
As this space between the back-up and conical rolls will vary with changes in the tube wall thickness, adjustments are made if required, by the mounting provided for carrying the conical roll.

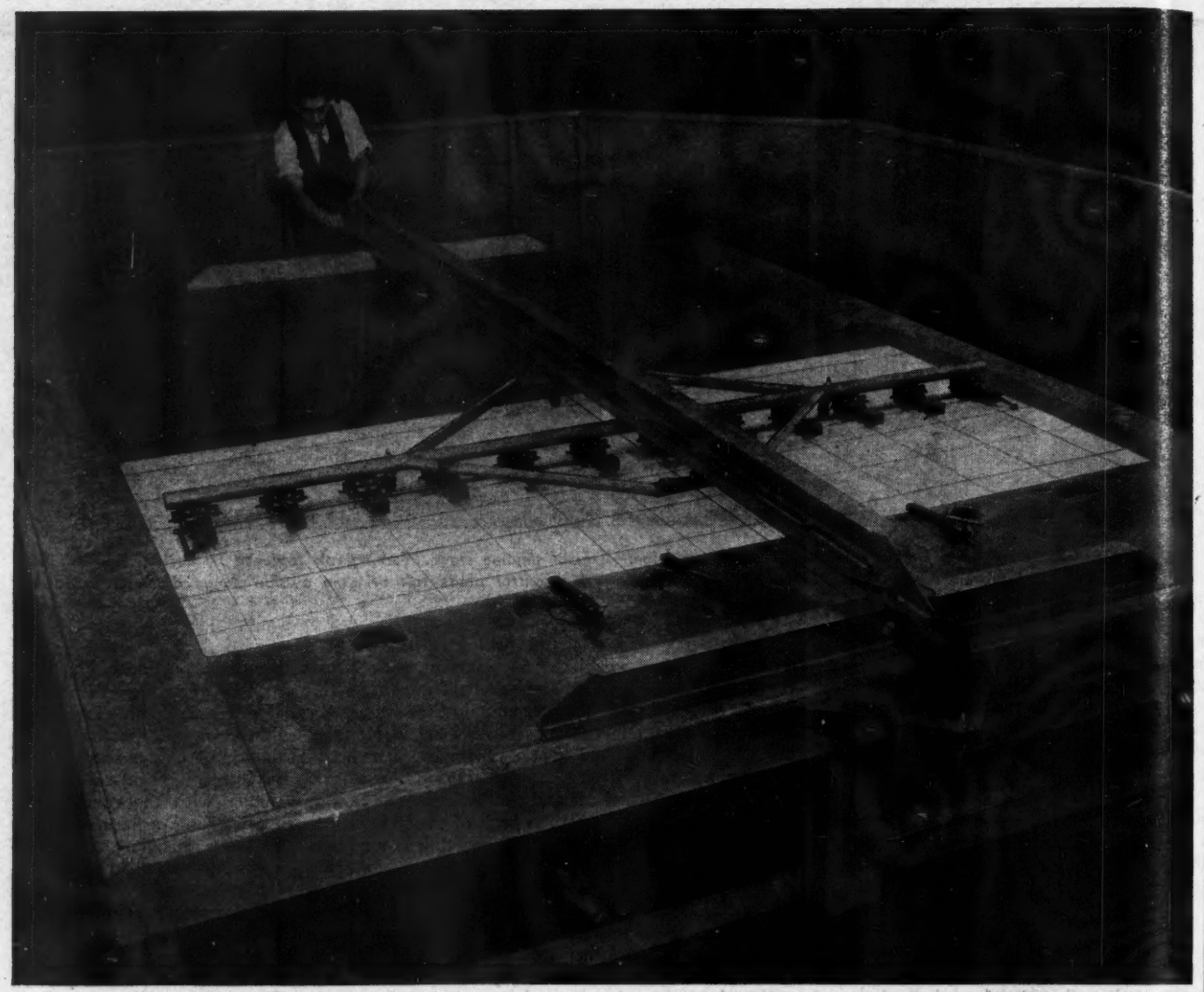
Rolling contact with the conical face forces the tube wall into a flare while the tube rotation causes this flare to assume uniform proportions round the circumference.

While the tube mouth is being flared by the conical roll, a turning roll is brought up against the flare perpendicular to the tube axis which crowds the flared portion

(Turn to page 249)

Final stage. Conical and turning rolls backed away while completed flanged tube is cut off by hand-operated parting tool. Total operating time, 2 min.





Gird machine consists of twelve scribing edges, carriage, guide beam, and squaring device all mounted on table as shown. Welded tubular carriage is mounted on rubber-tired wheels. Carriage travels on ball bearings along straight edge. Photograph shows machine in operation, movement being actuated by crank operated cable.

New Machine Assures Drawing Accuracy

By **LYLE L. PIERCE,** *Master Layout Supervisor, Boeing Aircraft Co.*

Mechanically scribed grid lines speed production of *Flying Fortress* and *Superfortress*. Grids are used for master layout drawings.

INGREDIENTS from which wartime aircraft parts are made are not only metal, plywood, and plastics, but also "exactness" and "time"—the least possible time.

The time element, however, has been lessened through the development of new and more efficient tools and equipment, one of which is the Boeing grid machine. It has saved thousands of man-hours of engineering time by mechanically scribing grid lines on templates over eleven times faster than by hand methods.

With the advent of war there was a critical need for a great quantity of the best planes available. Among these was the Boeing B-17 *Flying Fortress*. The Vega and Douglas companies joined forces with Boeing to provide the greatest possible four engine bomber production. To get these two California companies in operation required the release of vast quantities of engineering information to the manufacturing shops of Southern California.

At about the same time the Boeing-Douglas-Vega production pool was organized a similar pool involving other companies was established for the production of the Boeing B-29 *Superfortress*, thus greatly increasing the burden imposed upon Boeing's engineering division. This entailed immediate release of engineering information on two different airplanes to the manufacturing shops of several companies. This matter was released in the form of master layout drawings.

These master layouts, drawings made to exact size on large sheets of steel and reproduced photographically, were used as patterns in production of all parts hydropressed or hammer-formed. The templates were used as bases for jigs, in the construction of dies, and as drill guides. The master layout department

provided drawings from which these templates were made and as far as fabrication and manufacture was concerned, the templates solved the problem. A way was needed, however, to improve the accuracy and lessen the drawing time.

The accuracy of the master layout drawings was in a measure assured by the use of grid lines. These lines, forming 10-in. squares, were the background of every drawing providing a basis for accurate dimensioning of the part.

Accurate grid lines were highly desirable. Before the development of any mechanical means of producing straight lines, human hands held the tools—cumbersome steel scales and long straight edges, resulting in lines without the high degree of accuracy required.

Overshadowing even accuracy was the tremendous time element, for 5,600 hr. were spent in drawing reference lines on the master layouts for frames and bulkheads of one model alone.

The engineers required some mechanical means of producing straight lines, perhaps a type of beam with cutters attached which could be lowered and moved across a sheet of lacquered metal cutting perfect reference lines. The Boeing master layout department set to work on the problem and the grid machine, a "robot" means of scribing lines, was the result.

This machine consists of twelve scribing edges, a carriage, a guide beam, and a squaring device all mounted on a table.

The scribing edges are of tungsten carbide hinged to permit lowering and raising before and after the cutting operation. Depth of lines can be controlled by varying the pressure exerted on the scribers.

Twelve scribers are mounted in brackets, adjustable to an accurate 10 in.-spacing by a special wrench which simultaneously turns two adjusting bolts. The brackets are in turn fastened on a carriage of welded tubular members. Mounted on three rubber-tired wheels, the carriage travels on four ball bearings along a straight edge, underslung from a beam.

In using this machine the sheet to be scribed is laid on the table and clamped in position. The cutters are lowered and the carriage is propelled across the sheet by a crank operated cable. Result: Twelve clean, straight lines on the layout sheet, accurate to .001 in.

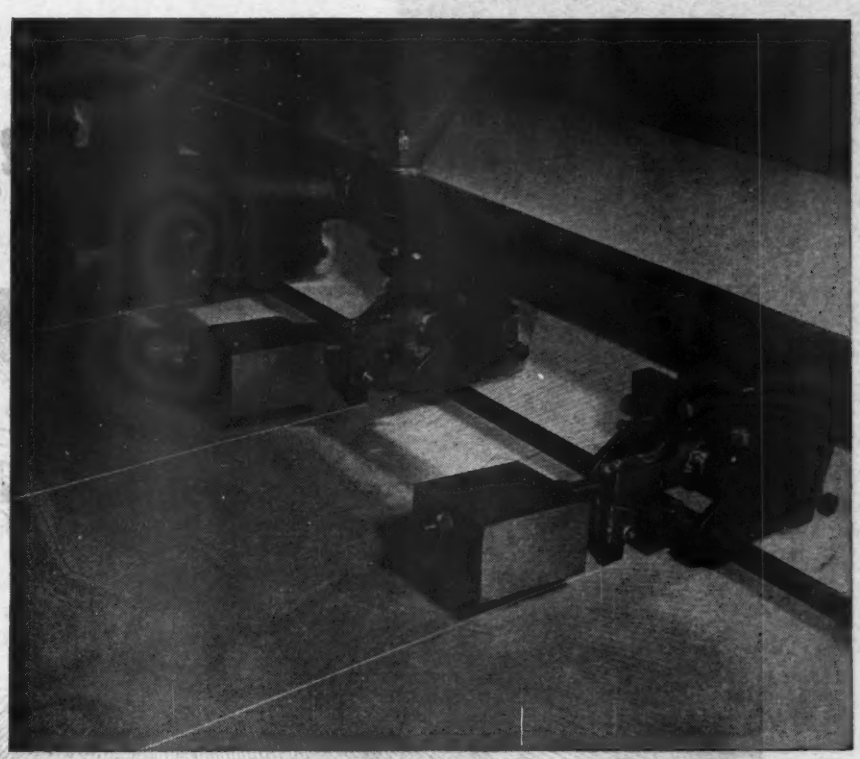
To get the needed perpendicular lines, the sheet is turned at right angles and the operation repeated. Mechanical gridding provides an accurate and reliable foundation for all layout work.

Accurate lines also simplify alignment of multi-sheet drawings. Full size drawings of bulkheads for four engine planes require four or five 5 x 10-ft. master layout sheets, but the grid machine eliminates alignment problems. Small holes at their edge allow the sheets to be bolted together after alignment.

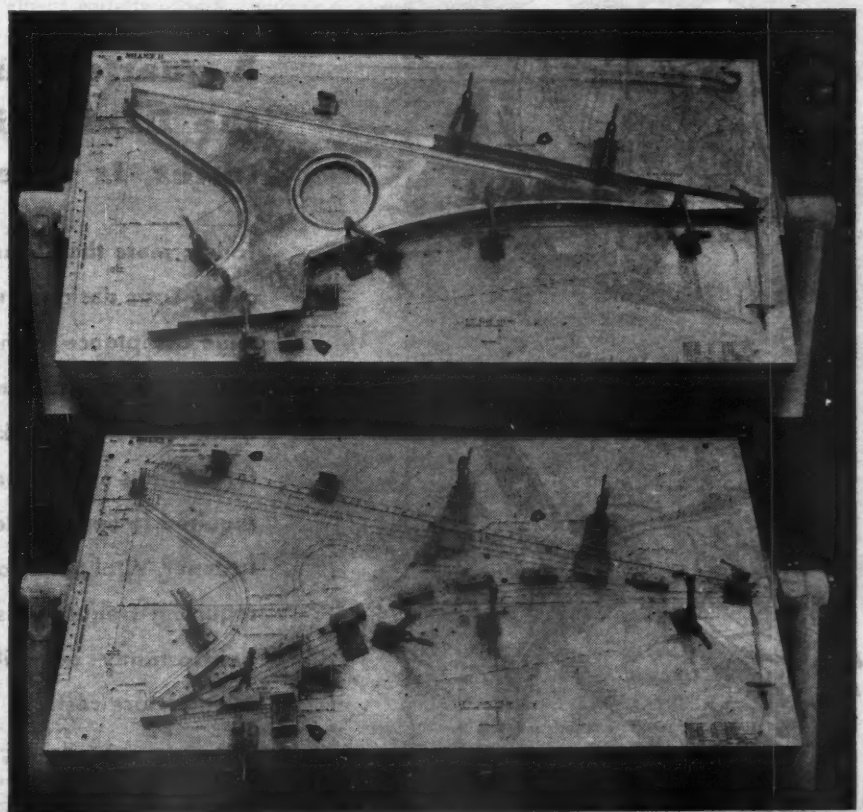
True intersections at grid lines also eliminate the necessity of adding focus points to the layouts since the grid may be used as a basis for focal length adjustment and for checking the accuracy of the reproductions.

Reproduction accuracy is important, especially on a detail template which is a reproduction of only a portion of a master layout. The accurate grid lines on the detail template furnish a means of verifying the scale of the reproduction, for grid spacing is the same as on the original.

It is estimated that through the use of this machine more than 10,000 man-hours have been saved by Boeing engineers.

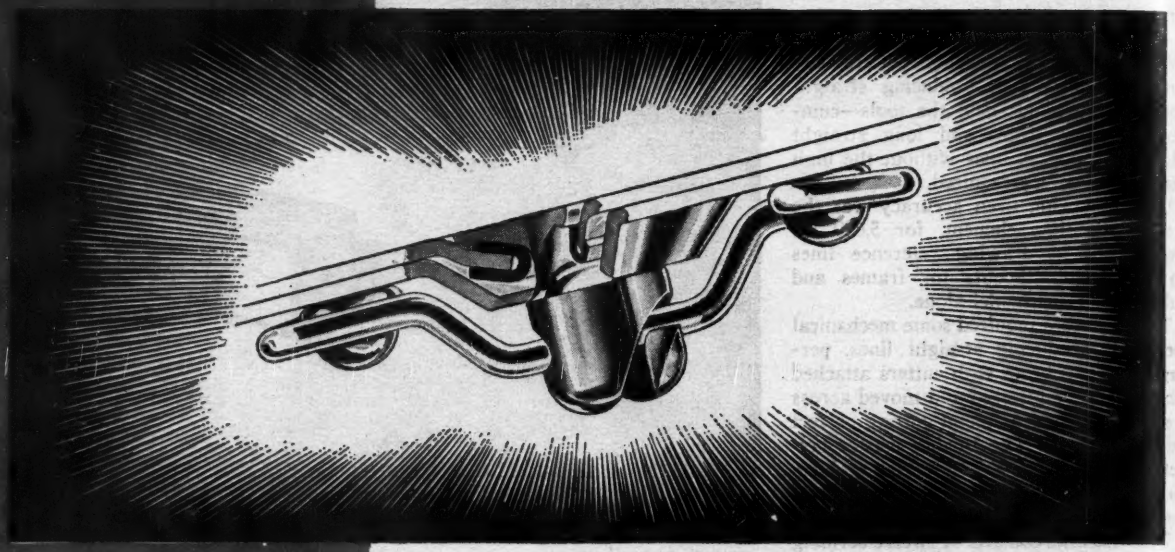


Shown here is detailed view of cutting mechanism. Note tungsten scribing edge, hinged to permit lowering and raising after cutting operation. Depth of lines is controlled by varying pressure on scribers.



Master layout drawings reproduced photographically on sheets of steel are used as patterns for all hydropressed or hammer forged parts such as wing rib pictured here.

DZUS* for simplicity



Newly designed spring with flush head stud

Easy to Install

Easy to Operate

A quarter turn and—click the Dzus spiral slot fastener *is open or locked*

Today, more than ever before, the *simplicity* of the Dzus design is the main reason for its wide acceptance in the aviation industry as the dependable fastener. It's easy to install, quick to operate. No knobs or gadgets interfere with its swift operation. No special tools required to open or close the Dzus spiral slot fastener. Vital points on the modern airplane requiring frequent inspection and servicing are instantly accessible. This helps slash maintenance costs.

*The word DZUS is the registered trade mark of the Dzus Fastener Co., Inc.

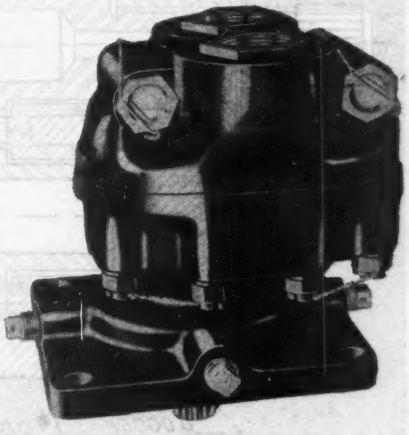
DZUS TRADE MARK FASTENER CO., INC.

BABYLON NEW YORK

In Canada—Railway and Power Engineering Corp. Ltd.

Hard Working Hydraulic Pumps Warrant Careful Service

When several tons total pressure are concentrated in a vital unit no larger than a man's fist, Pesco's service instructions given here become of considerable importance.



Pesco pressure-loaded, end-port hydraulic pump.

PUMPS for operating hydraulic equipment work at pressures up to 1,500 psi. and though all built on the same principles, vary somewhat in details of mounting flanges, pipe connections, etc.

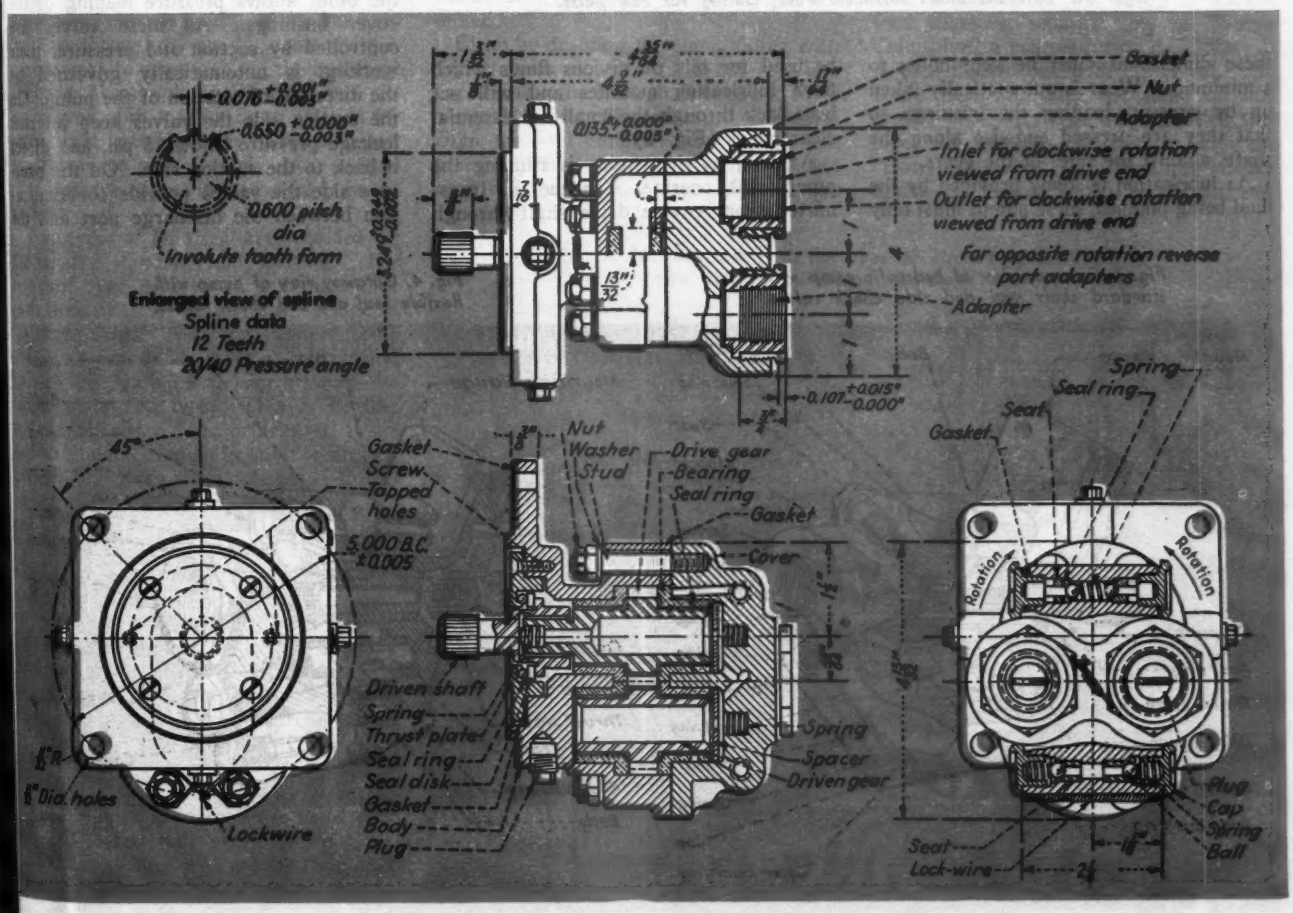
Rotation in either direction is permitted without alteration or adjustment by the use of two sets of check valves, which also provide lubrication and pressure load the cover bushings.

Though the Pesco pump is the one specifically described, the instructions for servicing mostly apply to any standard type of hydraulic pump now used in aircraft work.

Pesco hydraulic pumps are engine-driven, pressure-loaded, positive displacement, gear type, consisting of two steel gears in a casing, the drive gear meshing with the driven one and being turned by a shaft from the engine. (Fig. 1).

Casing consists of a body and cover with matched pairs of loose-fitting bushings. The efficiency of the pump depends almost entirely upon the amount of clearance between the gears and casing, so

Fig. 1 Four-view drawing of typical Pesco hydraulic pump, with names of parts.



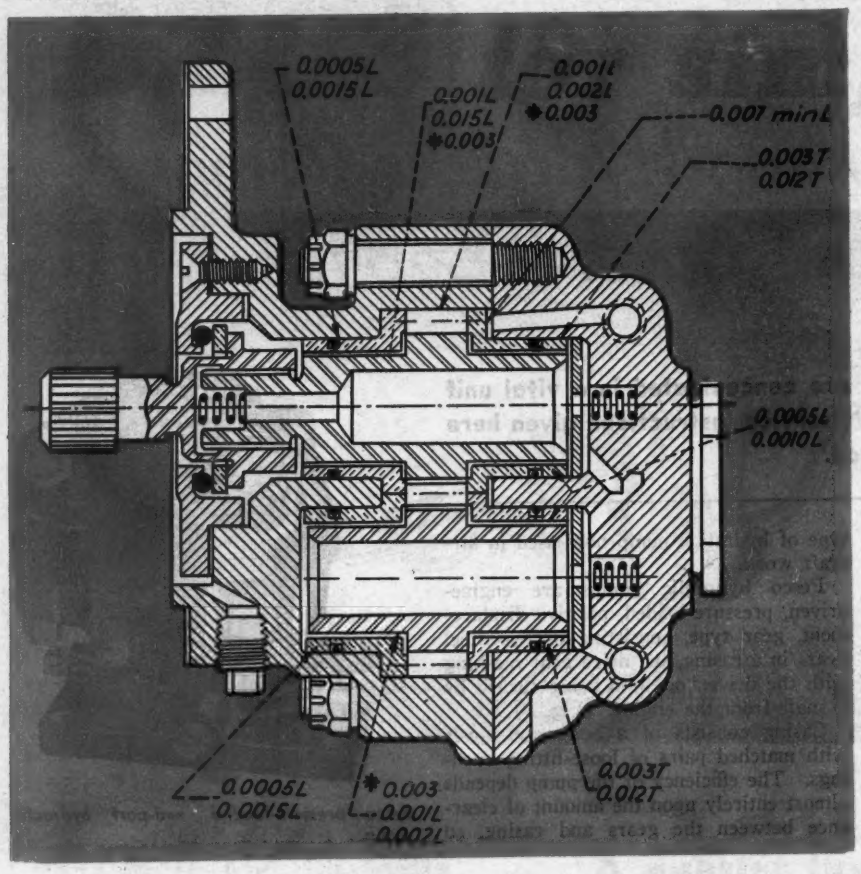


Fig. 2. Wear and fit limits diagram. "L" indicates loose and "T" tight fit. Asterisks shows maximum wear, calling for new parts.

these dimensions must be kept down to a minimum. Wear is automatically taken up by pressure-loading the bushings so that they are pressed endwise along the shafts against the sides of the gears.

As lubrication is solely provided by the fluid being pumped, these pumps must only be used for oils or viscous fluids which have lubricating qualities and will not leak back through the small but essential clearances. (Fig. 2)

As long as the engine is running the pump will operate. Torque is transmitted from engine drive shaft through pump drive shaft (Fig. 1, 3, 4 and 5), to pump drive gear and driven gear. On side where gears disengage, separation of teeth causes suction, which fills spaces between gears with fluid which is carried round outside of gears until reengagement of teeth forces out the fluid between them.

Each bearing has a flange held against the end of the gear by fluid pressure from the discharge port. The bearing has a seal ring on its smaller outside diameter, which returns the pressure fluid between the flange and housing. The bearing is loose enough so that this pressure moves it against the gear and maintains a constant minimum working clearance.

Pressure loading valves admit fluid from pressure port to space between bearing flange and housing and also check flow to intake port. Scavenging valves admit fluid from bearings and seal cavity to intake port and also check flow from outlet port. With reverse rotation the opposite valves function in the same manner. Four drain ports in the mounting flange drain off any leakage past the drive seal.

Cover contains inlet and outlet ports. These are either "end" or "side" ports according to their position. In some models end ports extend at an angle of 10 deg., to center line to facilitate installation. Covers have either pipe threads or steel port union adapters for direct tube connections. The cover is provided with two pairs of 15-lb. spring-loaded ball check valves. One set provides lubrication while the other allows pressure loading of the cover bushings. As these valves are controlled by suction and pressure, their working is automatically governed by the direction of rotation of the pump. On the suction side the valves keep internal leakage pressure below 15 psi. and direct it back to the suction side. On the pressure side the valves provide communication between the discharge port and the

Fig. 3. Cutaway view of hydraulic pump with standard shaft seal and side check valves.

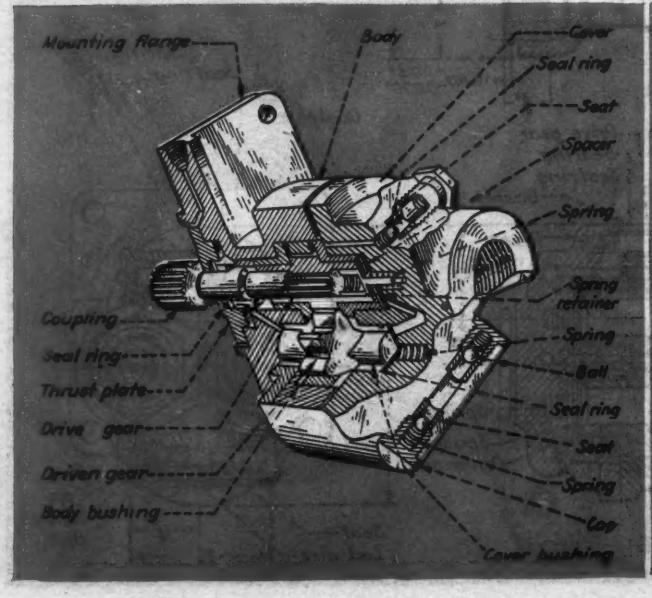
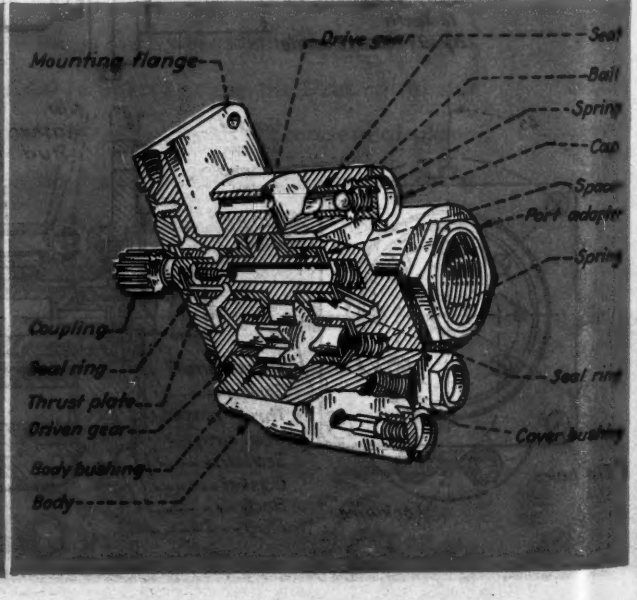


Fig. 4. Cutaway view of pump with flexible seal and end check valves.



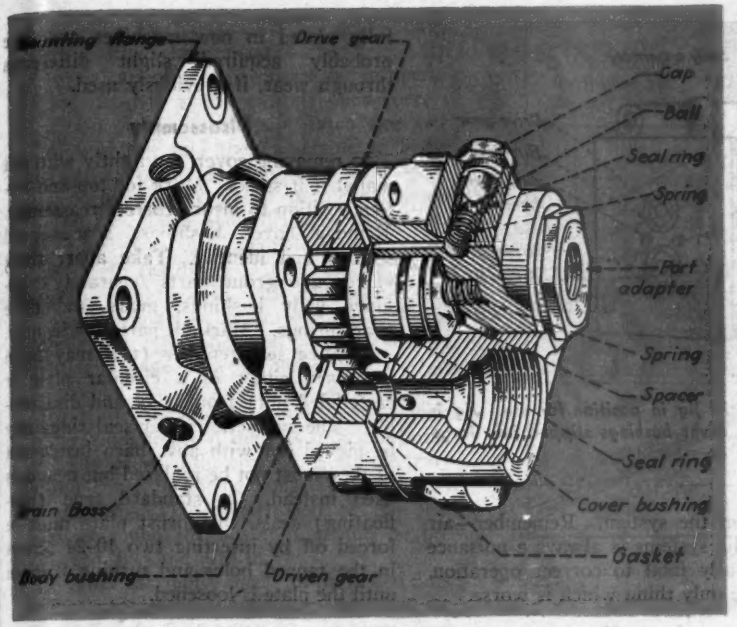
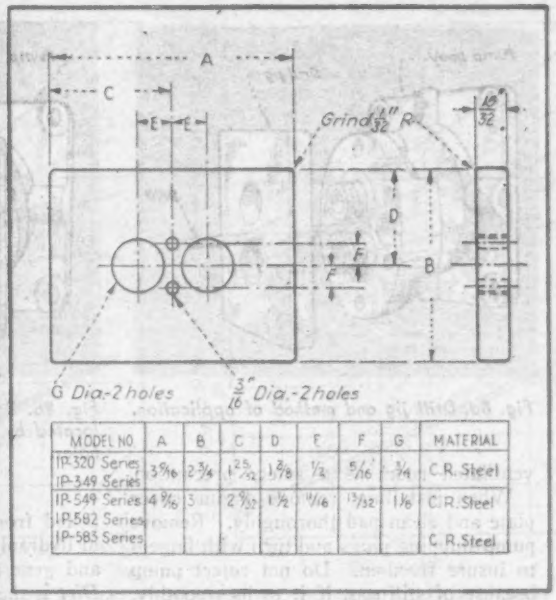


Fig. 5. Parts which require checking at inspection.



MODEL NO	A	B	C	D	E	F	G	MATERIAL
IP-320 Series IP-349 Series	3 5/16	2 3/4	1 25/32	1 3/8	1/2	5/16	3/4	C.R. Steel
IP-549 Series IP-582 Series IP-585 Series	4 5/16	3	2 5/32	1 1/2	11/16	13/32	1 1/8	C.R. Steel C.R. Steel

Fig. 6. Dimensioned drawing of bushing drill jig. This may be made from piece of cold rolled steel.

back of the bushings, thus pressing them against the gears and reducing clearances to a minimum.

Two matched bronze bushings, exactly like those in the body, are fitted in the cover and are also sealed with synthetic rubber rings. Spring-loaded spacers keep the bushings in contact with the gears until enough fluid pressure has been built up through by-passing from the discharge port to pressure load the bushings.

Drive shaft splines directly into the drive gear with a loose fit to provide for any slight misalignment through wear. It is provided with a safety shear section to protect the engine in case of jamming in the pump.

Two types of fluid seal are provided for the shaft; standard and floating. The *standard type* consists of a bronze disk cushioned against the nitroloy surface of the drive shaft. A spring between shaft and pump gear holds parts in contact and presses the flexible seal ring between the thrust plate and disk. This is flexible enough to allow the surfaces to make perfect contact, even if the shaft is slightly out of line. Normal leakage up to 15 psi. permitted by the ball valve, renders the seal partly pressure-loaded.

Floating seal resembles the above with addition of a cup against which the seal disk seats. This cup is held in position on the shaft by a light spring and has an internal seal ring bearing on the external diameter of the shaft. This construction makes the seal proof against slight variations in alignment of end thrust caused by shouldered spline teeth.

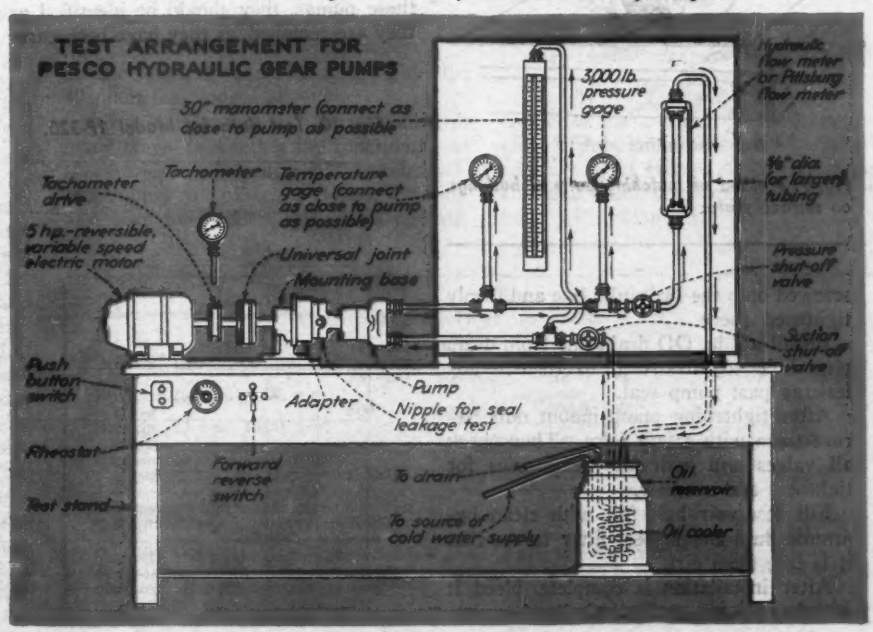
Installation

As all pumps in storage are filled with engine oil, they will only require to be drained and flushed with specification 3580 (mineral) oil, if that oil is to be used in the hydraulic installation. However, if specification 3586 (castor) oil is to be used as hydraulic fluid, a thorough cleaning of the entire pump mechanism is necessary, as the admixture of only a trace of either oil with the other will result in considerable subsequent trouble through gumming, which always occurs when the oils are mixed.

Clean by draining the pump, filling with dry cleaning solvent (P-S-661-A), and then turning the drive shaft back and forth about 30 times. The oil must be washed from the seal chamber and the solvent drained. This operation must be repeated until the pump has been cleaned five times, each time with fresh liquid. Before this operation entire pump should be immersed in a container of solvent and the drive shaft revolved by hand. The solvent is then blown out of the pump with sufficient air pressure to insure that it is entirely dry.

After the above, the pump is washed four times in separate lots of "Butyl-Cellusolve" a component of AC 3586. It is then flushed out with castor oil. Fill pump half full with the same oil and install. Use care that the enamelled surfaces do not come in contact with the "Butyl-Cellusolve" as it dissolves enamel finish. This work should be done in well

Fig. 7. Test equipment for any type of aircraft hydraulic pump. Most of these fittings are already on hand in many hangars.



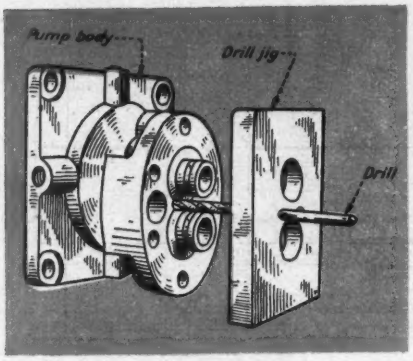


Fig. 8a. Drill jig and method of application.

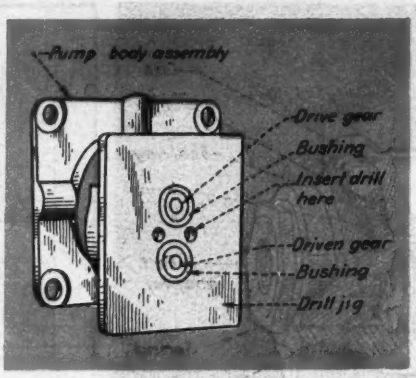


Fig. 8b. Drill jig in position for use. Jig is located by cover bushings slipped into large holes.

ventilated room as a safety precaution.

When installing, remove engine cover plate and clean pad thoroughly. Remove pump shipping plugs and turn with fingers to insure freedom. Do not reject pump because of stiffness, if it turns smoothly, as coupling tension springs cause close fit on the gears.

Coat drive splines or tongue with lubricant AC 3590 and apply a thin coat to all male pipe threads, keeping first thread clear to prevent any chance of lubricant entering pump. Mount with gasket against engine pad and be sure that one of the $\frac{1}{8}$ I.P. plugs is at lowest point as a drain.

Suction line should be tested before installation of pump by plugging and then applying vacuum of at least 20 in. Hg which should be maintained (sealed) for five minutes.

Union port adapters should be tightened down and safety wired in place, first being

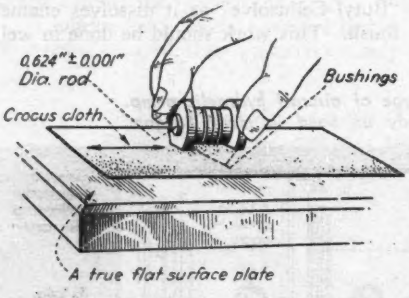


Fig. 9. Method of matching pairs of bushings on surface plate.

screwed onto the hydraulic line and firmly tightened there.

Install a $\frac{1}{4}$ in. OD drain line from drain plug hole to slipstream to remove any leakage past pump seal.

After tightening pump mount nuts, secure them with safety wire. Then check all valves and hydraulic accessories for tightness and security.

Fill reservoir half full with clean hydraulic fluid and inspect filter to see that it is free from dirt.

After installation is complete, bleed it with hand pump until all air has been expelled from the system. Remember—air in hydraulic systems is always a nuisance and generally fatal to correct operation. *Dirt* is the only thing which is worse.

Inspection

After first 50 hr. operation pump should be removed and tested by hand for freedom of movement. If excessive resistance is found, send for overhaul.

After 100 hr. pipe connections should be wrench checked and drive coupling safety shear inspected. If coupling shows signs of undue wear or overwork, replace pump with another.

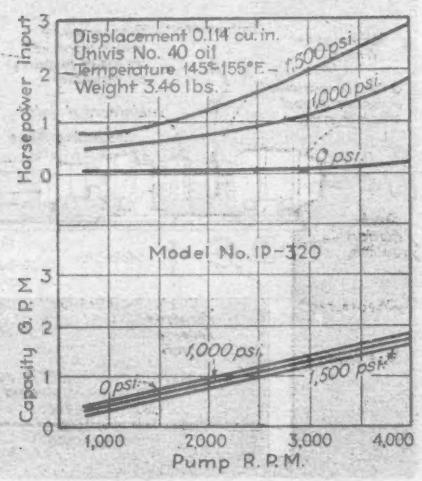
Normally, pumps will not require overhaul more frequently than at engine overhaul periods.

Overhaul

Though no special tools other than drill jig shown in Fig. 6 are required pump overhaul should not be undertaken unless facilities for repair and testing are available. Test bench is shown in Fig. 7. which is self explanatory. Test procedure will be given later in this article.

As there are several identical parts in these pumps, they should be identified as they are removed, as they have been carefully mated in new machines and have probably acquired slight differences through wear, if previously used.

Fig. 10. Test data for Model 1P-320.



Disassembly

In removing cover, tap lightly with soft mallet if it sticks. Mark for top and bottom position to insure correct reassembly. Remove cover bushings, spacers and springs and identify. Take apart check valves and group parts separately. Remove body bushings, gears and drive gear springs. Mark all parts for identity.

Remove seal retainer (this may be in the form either of a circular plate or castelleted nut) from body and disassemble. The synthetic rubber seal rings may be picked out with any sharp instrument as they must not be replaced but new ones used instead. In standard type (non-floating) seals, the thrust plate must be forced off by inserting two 10–24 screws in the tapped holes and turning them in until the plate is loosened.

Inspection and Repair

After disassembly, wash all parts in gasoline or cleaning fluid. Check wear at all points shown in Fig. 2. Replace all parts with new ones if wear is in excess of figures marked with asterisk. In addition, inspect all threads and examine mounting flange for bending or cracks.

Even though bushings may appear to be worn considerably on faces, due to pressure loading, they may be used again unless wear is above that permitted by Fig. 2. New seal rings must be fitted.

If new bushings are installed they must first be matched. If flats of bushings overlap or fit so tightly that wedging in the holes results, the flats must be trimmed slightly to provide a correct fit. Insert drillrod (of same diameter as gear shaft) through a pair of bushings and dress carefully on crocus cloth laid over a flat surface. Test carefully at frequent intervals to see if sufficient material has been removed, as there should be no measurable gap between the finished flats when the bushings are installed.

Inspect both internal and external splines for wear or burred edges. Smooth down any roughness with smooth carborundum slip.

Floating seal parts should be inspected for wear and smooth seating between disk and face of drive shaft. If surfaces are not perfect they may be lapped in with very fine lapping compound. Other seal parts should be checked for wear or damage.

Inspect edges of gears and hone off any rough edges on teeth.

Reassembly

Clean all parts and inspect carefully any which have been lapped or stoned. The assembly operation is the reverse of that given under "Disassembly." All external screw threads should be coated with thread compound, AN-VV-C-566, leaving the first entering thread free of compound to insure that none of it will find its way

into the mechanism of the gear pump.

Installing new bushings requires very special attention as accurate pump operation depends almost entirely upon correct action of the bushings. Match two sets of bushings and then assemble in body. Continue pump assembly until cover bushings have been placed on gears, as in Fig. 8a. Then place drill jig (shown in Fig. 6) over small diameters of bushings and drill two holes 3/16 in. dia. and ⅛ in. deep, using a drill with end ground flat for finishing the bottom of holes. These holes are for rubber seal plugs preventing back leakage between bushings.

When placing cover and body together over the assembled bushings, press with the hands to see if there is sufficient bushing freedom in the cover to cause the body and cover to spring apart slightly when released. The compression of the seal rings round the bushings should be between .003 and .010 in.

After assembly, check all parts and nuts for completeness and turn by hand to test freedom of rotation. If parts tend to stick, rap sharply with soft hammer. If still unsatisfactory, disassemble to discover cause. When pump turns freely, proceed with final test.

Final Test

Test equipment (Fig 7) should include a pump mounting fixture, the shaft of which can be connected to a driving motor or electric cradle dynamometer by a flexible coupling. The driving unit may also be an electric motor with variable speed drive.

Test pump for freedom by turning by hand. Install securely on adapter Bleed system until certain that no air is present. Install a nipple in lowest drain port to check seal leakage.

If pump has been fitted with new bushings at overhaul, it should be run in as given in Table I. Use clean hydraulic oil heated to specified temperature. If original bushings are used, five minutes are all that will be required for smoothing out seals.

After run in, pump is tested at speeds and pressures given in test data in Figs. 10, 11, 12, 13 and 14, usual speeds are 1,500 and 4,000 rpm. with a short test at 500 rpm. if other tests indicate that low speed test is needed. Loss of pumping capacity is to be expected in overhauled pumps and should not be considered cause for rejection unless over 10 percent. Before blaming a newly overhauled pump for reduced capacity, check connections and piping for leaks, also watch the tachometer for motor speed reduction under load.

If seal leakage exceeds that specified, replace seals with new ones. Before doing this, examine metal seal contacts for roughness which would damage new seals.

Restrictions in pressure line will cause loss of pressure at accessories and excessive pressure at pump. Small return lines cause back pressure. Many angle fittings greatly increase resistance and absorb a lot of pressure, a 90 deg. bend with inside radius equal to pipe diameter has a resistance roughly equal to a straight pipe 40 diameters long.

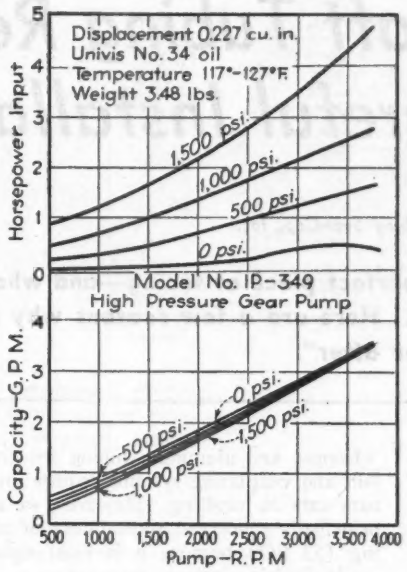


Fig. 11. Test data for Model 1P-349.

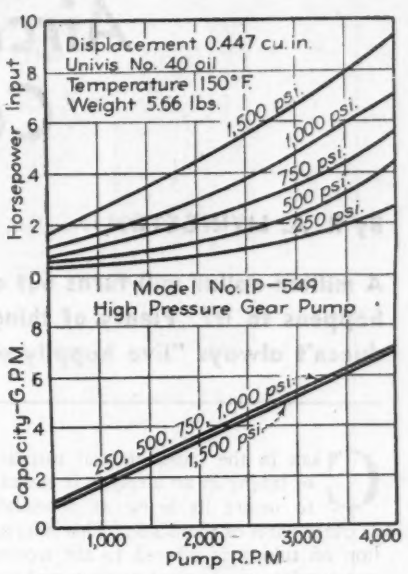


Fig. 12. Test data for Model 1P-549.

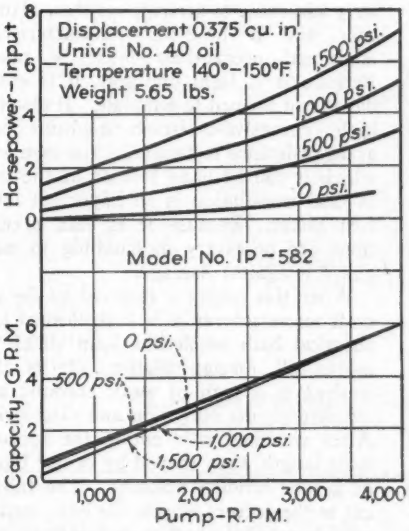


Fig. 13. Test data for Model 1P-582.

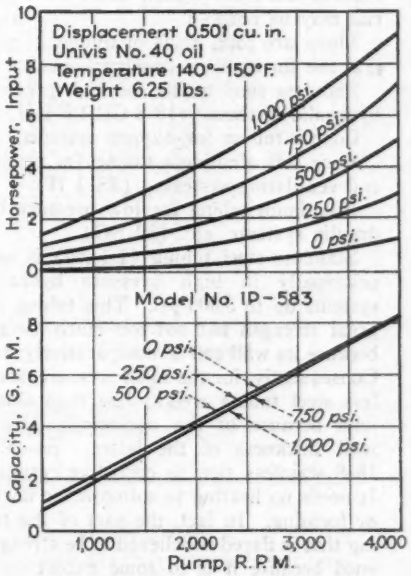


Fig. 14. Test data for Model 1P-583.

Air in the system will cause trouble in many ways, preventing the functioning of accessories in some cases and causing malfunctioning in others. Before blaming any part for sudden refusal to operate, check for air and dirt in the system and clean all strainers of filters. Be sure that pressure relief valve is correctly connected and that fluid reservoir is at least half filled with clean oil.

Table I—Final Test Data

Test	1P-320	1P-349	1P-549	1P-582	1P-583
Breakin; 1 hr. 2,000 rpm. at psi	200–600	200–600	200–1,000	200–1,000	200–800
Breakin; 20 min. 3,000 rpm. at psi	500	200–1,000	200–1,500	300	300
Breakin; 20 min. 4,000 rpm. at psi	1,000	200–1,000	200 1,500	600	600
Breakin; 20 min. 4,000 rpm. at psi	1,500	200–1,000	(5 min.)1,500	1,000	1,000
Seal leakage test psi. at max. 5 dpm	1,500	1,000	1,000	1,500	1,500

Capacity and power tests made from data given in graphs for individual models. Air seal test at zero pressure, 12 in. Hg suction, 4,000 rpm., oil temp. 150 deg. F. no air should be found in pump discharge after few minutes running

Aircraft Tubing Requires Careful Installation

By R. A. LIVINGSTON, *President, Tubing Seal-Cap, Inc.*

A million-dollar mill turns out a perfect piece of tubing—and what happens to it? Plenty of things. Here are a few reasons why it doesn't always "live happily ever after".

CARE in the handling and installing of tubing in an airplane is essential to insure its being as dependable as other parts of the plane. This information on tubing is offered to aid workers and service men in the knowledge of their jobs, to the end that accidents due to line failures and costs in man hours and material may be reduced.

There are four kinds of tubing in general use for airplane construction:

Stainless steel tubing for high pressure hydraulic systems. (18–8 GR IS–¼ H)

Copper tubing for oxygen systems.

Very soft aluminum tubing for conduit and ventilating systems. (3S–½ H)

Aluminum tubing for low pressure hydraulic systems, etc. (52 SO)

Stainless steel tubing (¼ hard) is used principally in high pressure hydraulic systems up to 3,000 psi. This tubing has great strength but not too much weight, because its wall can be comparatively thin. Consequently, for the same pressure, stainless steel tubing weighs less than aluminum because of the necessarily greater wall thickness of the latter. So-called 18–8 stainless steel is corrosive resistant. It needs no heating to soften it for flaring or forming. In fact, the part of the tubing that is flared is believed to be strengthened because it is to some extent strain hardened.

Stainless steel tubing is used on all landing gear, for brakes and for oleo balance lines because of its resistance to damage from gravel thrown by the wheels during take-offs and landings.

Copper and aluminum tubing for conduit and ventilating systems require ordinary care in handling. However, we are principally concerned with aluminum tubing (52 SO) because it is most extensively used in airplane construction.

Aluminum tubing (52 SO) has certain valuable properties which make it particularly adaptable to aircraft systems. However, due to these very characteristics, additional precautions must be taken. Because it is light and soft, it is easily flared and formed to template. It also has high corrosive-resistant qualities and great resistance to fatigue. The ease with which it can be hand formed at the time of final installation is an important labor cost factor. Because it is soft, precautions are necessary in handling to safeguard it against damage.

When this tubing is received by the aircraft manufacturer it is first cleaned in a chemical bath much like soap which removes all foreign matter. It is then washed in a bath of weak chromic acid which prevents corrosion and discoloring. After washing, it is cut to the approximate length, then shaped by radius blocks or a tube bending machine. The tube is cut to the correct length, the ends squared off, sharp edges broken to keep the tube from cracking when flared, and all burrs are removed.

After this it is again cleaned and is ready to be flared. Prior to flaring, however, the BT nuts and sleeve must, if indicated, be installed on the tube, which is then ready to be machine flared. With the AAF 811 type fittings the flared portion must retain at least 82 percent of the original wall thickness of the tube and the flare extend .045 to .060 in. beyond the tip of the sleeve as indicated in Fig. 1.* If the tube is accepted, it is pressure tested (if a test is called for). All BT nuts are tightened to the minimum torque load shown in Tables I and II for the test and afterwards the tube is seal-plugged, banded and stamped with a part number. It is now ready for inspection and installation. If it is not to be put to immediate use, the tubing is stored in racks.

Stock racks should be designed so that there is no tendency to pile one piece on another. Racks should be placed where they will be free from falling objects and they should be fenced off so that only qualified workers will have access to them. Loading or handling mixed shapes may result in scarring or bending. Closures in the line should not be removed as they provide protection against foreign matter and protect the flare and fittings. Dents in the tube, if not greater than 20 percent of the diameter of the tube, will cause no trouble unless on the heel of a sharp bend. If a nick or scratch is no deeper than 10 percent of the wall thickness it may be reworked by burnishing (Fig. 2).

Vibration tends to concentrate at the weakest point, which may be that of the scar. Burnishing of the tube scars should be done with special tools and never with sand paper or similar abrasives. Only aluminum tubing should be burnished. Burnishing is merely an attempt to smooth down the edges of the scratch and redistribute the strength of the wall at that point. Any rework job should be inspected prior to and upon completion of the operation. This rework applies to

* Exception—Flares for 1/8" o. d. lines of 52 SO and copper lines for fuel and oil must retain 70 percent of original wall thickness and must extend .025 to .040 beyond tip of sleeve when flared. AN type flares must be made to AND 10061 drawing (Fig. 3).

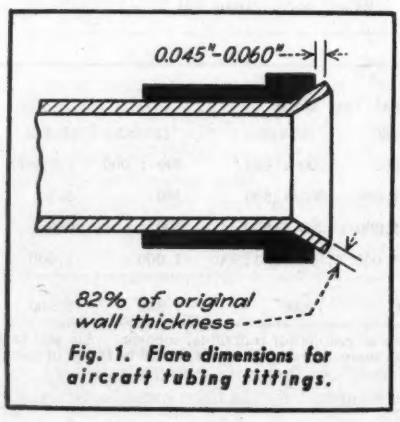


Fig. 1. Flare dimensions for aircraft tubing fittings.

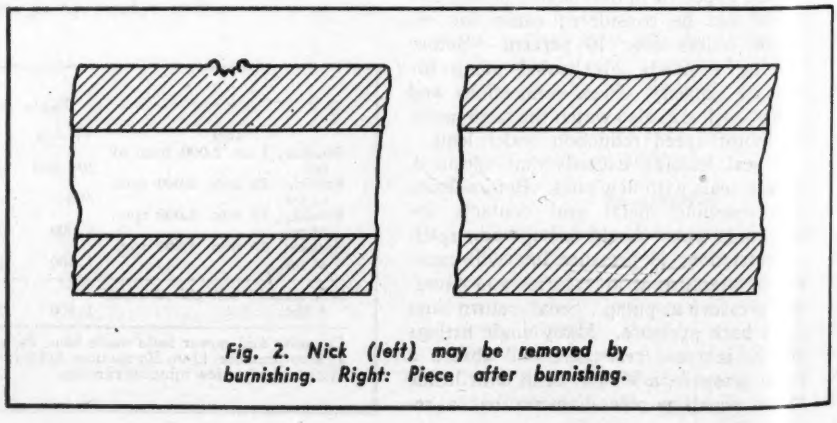


Fig. 2. Nick (left) may be removed by burnishing. Right: Piece after burnishing.

scratches only and must never be applied to cracks which might be defects in the tubing.

Dents are removed by drawing a "bullet" through the tube. This operation forces the dent back and out to the surface (Fig. 4).

The inspection of tubing requires considerable time and afterwards the tubing must be given the best possible care. A clogged or leaky tube can bring disaster in flight as readily as enemy bullets.

Metal caps and plugs properly used can reduce line spoilage and will keep out dirt, dust and moisture. After fittings are installed they should never be changed unless damaged. Unnecessary wear on the threads is thus eliminated. If the tubing is to be attached to a hydraulic unit, the fitting installation may be tested at the same time the test is made for the entire unit. Thus, two tests are made at the same time and no damage results to the body of the casting by screwing in fittings for test and then removing them, plugging up to the holes, and shipping the unit into the plant where it would need to be unplugged, and fittings re-installed.

Tubing assemblies clipped, tied or clamped in a jig may be capped or plugged, then removed from the jig and sent to the proper production line position. The closures or protectors are not removed until ready to hook-up to other units. In this way, it is possible to install all lines in a wing then join the wing to a fuselage and hook up the connections.

Lines should never be left open in a ship—they should be capped or plugged to prevent the intrusion of foreign matter.

Protectors, when removed may be sent back to the tubing department to be made ready for use again.

After fittings have been installed and lines made up, it is impossible to clean them thoroughly by blowing air or circulating liquid through them because in these lines, with their numerous bends and fittings there are a multitude of crevices, pockets and joints where the dirt will accumulate. This can easily be shown by running a hard small cord with a clean white cloth, through a blown-out or washed-out line—about in the same way a gun barrel is "swabbed out." Seeing the dirt, it can be imagined what the accumulation can be throughout the plumbing system of a plane.

As soon as tubing lines are made up, cleaned and inspected, protectors should be installed. If metal protectors are used, it is unnecessary to "blow-out" after installation of the lines in the plane. However, before installation all lines and fittings should be blown out with clean dry air. Special care must be taken with oxygen systems because moisture may be present which, if not eliminated, will contaminate the system, regardless of filters.

There are three types of standard fittings used on aircraft tubing. The AAF 810 B-nut type, the AN 818 and the AFF 811 BT-nut type, the latter two being the most used. Fig. 5 illustrates typical fittings and where to lubricate each. Note that on the BT nut the outside of the sleeve and the male threads of the fittings are to be lubricated, whereas, on the B-nut the tube flare and the B-nut thread are to be lubricated. All male or external threads except the first or starting thread are lubricated, but never female or internal threads. The lubricant should be sparingly applied to insure that none of it is forced out into the lines. Note also the lubrication chart which indicates that oxygen lines must have a special lubricant (AN-C-86).

On fittings of $\frac{1}{8}$ in. instrument lines, which come in contact with AN-VV-C-551 fluid, varnish should be used.

AN standard fittings, are now in use. From external inspection it is difficult to distinguish any difference between them and the AAF-811 BT nut type. In both cases, lubrication is indicated so that the nut will turn rather than the sleeve. If the sleeve should turn, it might cut through the flare. Although there is some difference in the angle of the flare and the sleeve on the AN the lubrication procedure is identical. Care should be taken not to confuse the AN BT-nuts and fittings with the others. The AN sleeve does not have a groove. The only working difference is a slight change in the

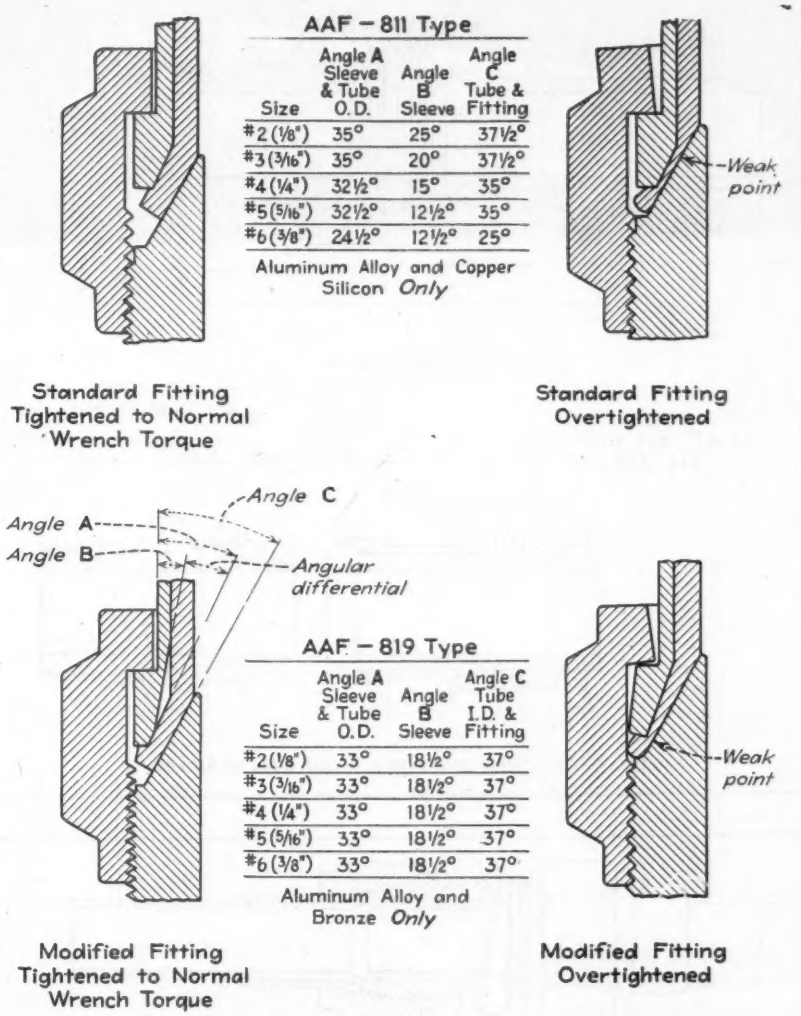

AAF – 811 Type
Size | Angle A Sleeve & Tube O.D. | Angle B Sleeve | Angle C Tube & Fitting
#2 (1/8") | 35° | 25° | 37½°
#3 (3/16") | 35° | 20° | 37½°
#4 (1/4") | 32½° | 15° | 35°
#5 (5/16") | 32½° | 12½° | 35°
#6 (3/8") | 24½° | 12½° | 25°
Aluminum Alloy and Copper Silicon Only
Weak point
Standard Fitting Tightened to Normal Wrench Torque
Standard Fitting Overtightened
Angle C
Angle A
Angle B
Angular differential
AAF – 819 Type
Size | Angle A Sleeve & Tube O.D. | Angle B Sleeve | Angle C Tube I.D. & Fitting
#2 (1/8") | 33° | 18½° | 37°
#3 (3/16") | 33° | 18½° | 37°
#4 (1/4") | 33° | 18½° | 37°
#5 (5/16") | 33° | 18½° | 37°
#6 (3/8") | 33° | 18½° | 37°
Aluminum Alloy and Bronze Only
Weak point
Modified Fitting Tightened to Normal Wrench Torque
Modified Fitting Overtightened

Fig. 3. Types of correct and incorrect tubing installations with either AAF-811 or AAF-819 type fittings.

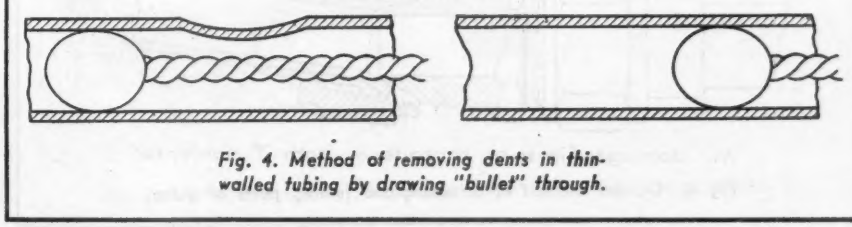


Fig. 4. Method of removing dents in thin-walled tubing by drawing "bullet" through.

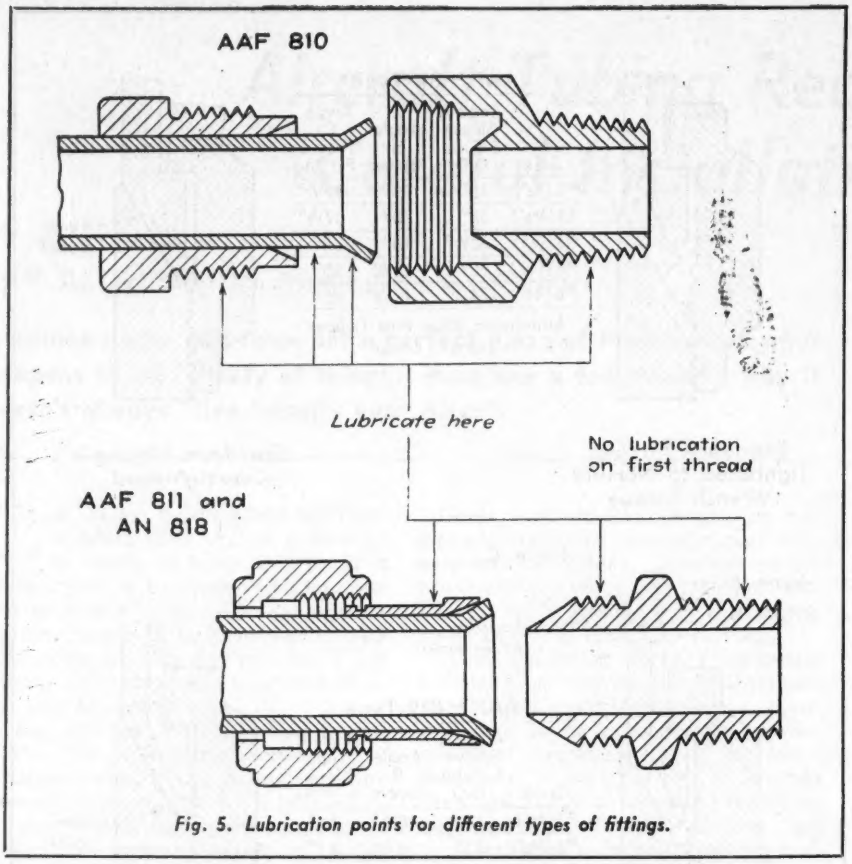


Fig. 5. Lubrication points for different types of fittings.

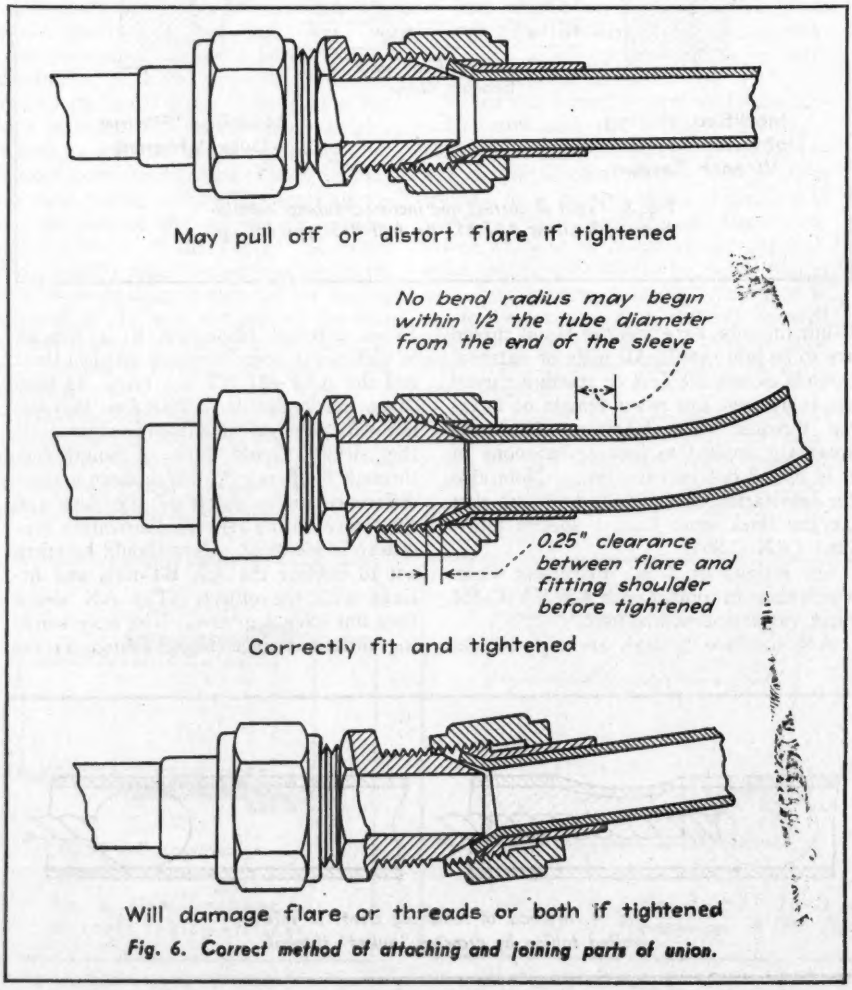

May pull off or distort flare if tightened
No bend radius may begin within 1/2 the tube diameter from the end of the sleeve
0.25" clearance between flare and fitting shoulder before tightened
Correctly fit and tightened
Will damage flare or threads or both if tightened

Fig. 6. Correct method of attaching and joining parts of union.

angle of the fittings and the number of threads per inch. If a *BT*-nut will not go on easily all the way, it should be checked to determine whether it is the right nut or fitting before ruining the parts. The latest AAF 811 sleeve is shorter and has no groove.

The AN specification calls for all AN series dural parts to be dyed a light blue and all steel fittings to be dyed black. All plated brass parts and all unplated AN brass parts left uncolored. This is to identify the parts easily. Any dye used for this purpose must be kept out of the inside of the fitting if it is soluble in the hydraulic fluid.

Installing Lines

Before installing lines a preliminary check of the tubing should be made. Flares and sleeves should be examined to see that they fit concentrically. They should also be examined for cracks. The tubing itself should be checked for dents or scratches. The sleeve should be examined to determine whether it is the proper one for use on that line. All lines and fittings must be blown out with clean dry air.

When installing lines, special care must be given to those passing through cut-outs because it is here more than anywhere else that tubing is scarred. Edges of cut outs should be taped and masked until lines are installed.

Tubing should be pushed against the fitting snugly and squarely before starting the BT nut which should not be used for drawing the tubing to the fitting because the flare might easily be spun off. To make sure that a snug, square fit is effected all nuts should be started on the fittings *by hand*.

TABLE I—Torque Loads in Lb.-In.

For tightening AAF 811 and Parker tube Fittings for 52 SO lines using aluminum alloy *BT* nuts and standard AAF 811 or revised sleeves. Also for AN standard fittings. These torque loads do not apply when other materials or combinations of materials are used.

Wrench size	Tubing dia.	Min. torque lb.=in.	Best torque	Max. torque
3/16	1/8"	10	13	16
1/4	3/16"	20	30	40
5/16	1/4"	40	50	65
3/8	5/16"	60	70	80
7/16	3/8"	75	100	125
1/2	1/2"	115	153	192
9/16	5/8"	150	200	250
5/8	3/4"	191	253	316
11/16	7/8"	200	275	350
1	1"	300	400	500
1 1/16	1 1/16"	394	525	655
1 1/8	1 1/8"	500	625	750
1 3/16	1 1/4"	505	675	860
1 1/4	1 3/8"	562	750	940
1 5/16	1 1/2"	675	900	1120
1 3/8	1 3/4"	788	1050	1310
1 5/8	2"	900	1200	1500

TABLE II—BT Nut Torque Loads Steel Lines*

1/16	1/16	60	80	100
1/16	1/8	100	125	150
5/16	3/16	150	175	200
3/8	1/4	200	225	250
7/16	5/16	325	362	400
1/2	3/8	475	525	575
1 1/16	1/2	650	712	775

*Only where the BT nut, sleeve, line and fitting are all steel shall the torque for steel lines apply In all other cases use the torque for aluminum alloy

Fig. 6 shows the proper meeting of the tube and connector.

Some of the newer fittings have a shoulder on the cone surface. There ought to be approximately .025 in. between the flare and the shoulder to provide enough space for drawing up when the *BT* nut is tightened. If this space is less than .025, the flare should be measured to determine if it has been made according to the blueprint. In the event of an error the flare or fitting should be reworked to conform.

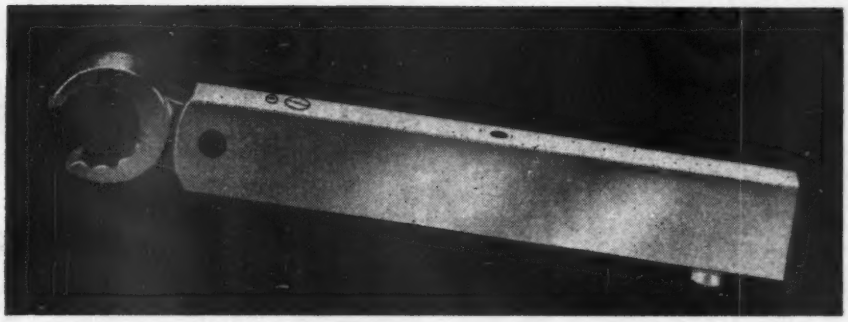
The use of levers and crow bars is not advocated. If a line requires considerable hand forming, the template should be checked to the line and to the ship to determine errors. Do *not* bend to a sharp radius or the tube may flatten and require removing. Remember that tubing is *not* to be bent *by hand* to a radius of less than six times and by machine to less than three times its outside diameter. Tubing installed in a plane should not be used as a footrest or ladder, nor should lamp cords or other weights be suspended from lines of tubing.

Inexperienced persons have a tendency to overtighten the BT nuts to insure the retention of the high pressure fluid. Overtightening causes damage to the flare of the tube and results in line failure in flight. If a flare is formed having less than 50 percent of the original wall thickness of the tube it must be rejected—never reinstalled. Undertightening is equally serious and also results in line failure in flight. It is, therefore, important that special men be delegated to apply the final tightening, particularly when proper tools are lacking, because practice and long experience are essential in order to apply the right torque to each size line.

Fig. 3 shows what happens when BT nuts are tightened to the desired torque as well as the effect of over tightening. These illustrations show that there is an angular difference between the sleeve and the flare. This is the accepted type of sleeve and flare for 52 SO tube sizes No. 2 to No. 6 ($\frac{1}{8}$" to $\frac{3}{8}$"). Formerly when the sleeve angle and the flare angle were identical, overtightening often caused line failure resulting from the flare being cut off at the base because it was not realized that small lines need less torque.

With the new type sleeve, even though the BT nut is slightly overtightened the base of the flare is still firmly held. When the nut is properly adjusted the sleeve bites slightly into the flare thus preventing the tubes from pulling out under pressure. Because stainless steel lines will withstand a higher torque than 52 SO, nickel steel (or equivalent) fittings and sleeves are generally used. A nut must never be tightened when there is pressure in the line as this will cause the flare to be cut without adding any appreciable advantage. If tightened properly a tube may be removed and replaced as many as 20 times.

Realizing the importance of precise tightening of fittings, a wrench depending on a combination of sound and touch has been found to answer the problem. It is simple in design and works on the principle of spring deflection which causes a secondary spring to snap over center when the load, for which the wrench is pre-set, is reached. This causes a slight drop in the torque and causes an indicator to project from the handle, producing an audible "clicking" sound. The double indication is evident to the user even under dark or noisy conditions.



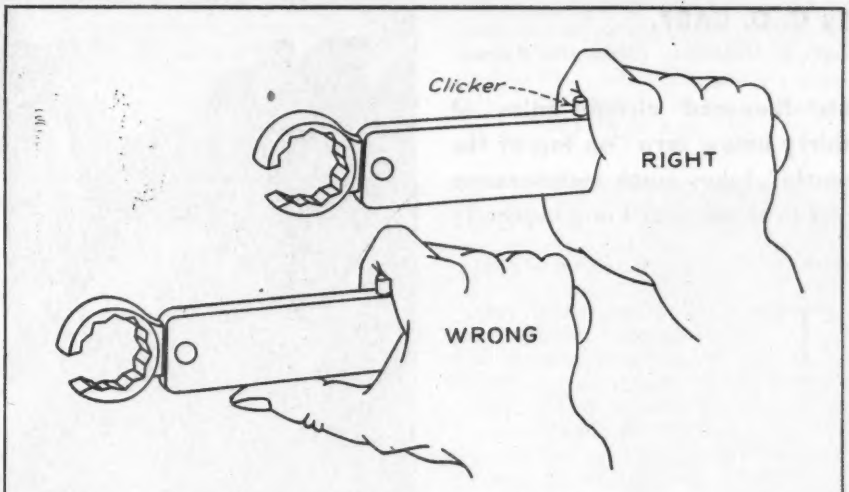


Fig. 7. Livermore torque wrench for fittings is shown at top. Above: Right and wrong ways of handling torque wrench.

Each wrench is pre-set for the nut it fits and torque is marked on the case.

By the use of this wrench overstraining of joints is eliminated. A joint which leaks after proper load is applied should be examined for faulty cone, cracked flare or some other defect. After a nut is tightened no outside inspection will disclose if the flare is damaged.

When using stainless steel tubing the torque loads are of unusual importance because the nose of the fitting may be so badly damaged that it can never be reused. A torque wrench relieves the operator of making a decision as to when the proper torque is reached. Note illustration on proper holding of tubing torque wrench (Fig. 7).

Finally, Fig. 8 shows application of Seal-Caps and Seal-Plugs.

Fig. 8. Method of applying Seal-Caps and Seal-Plugs when shipping accessories.

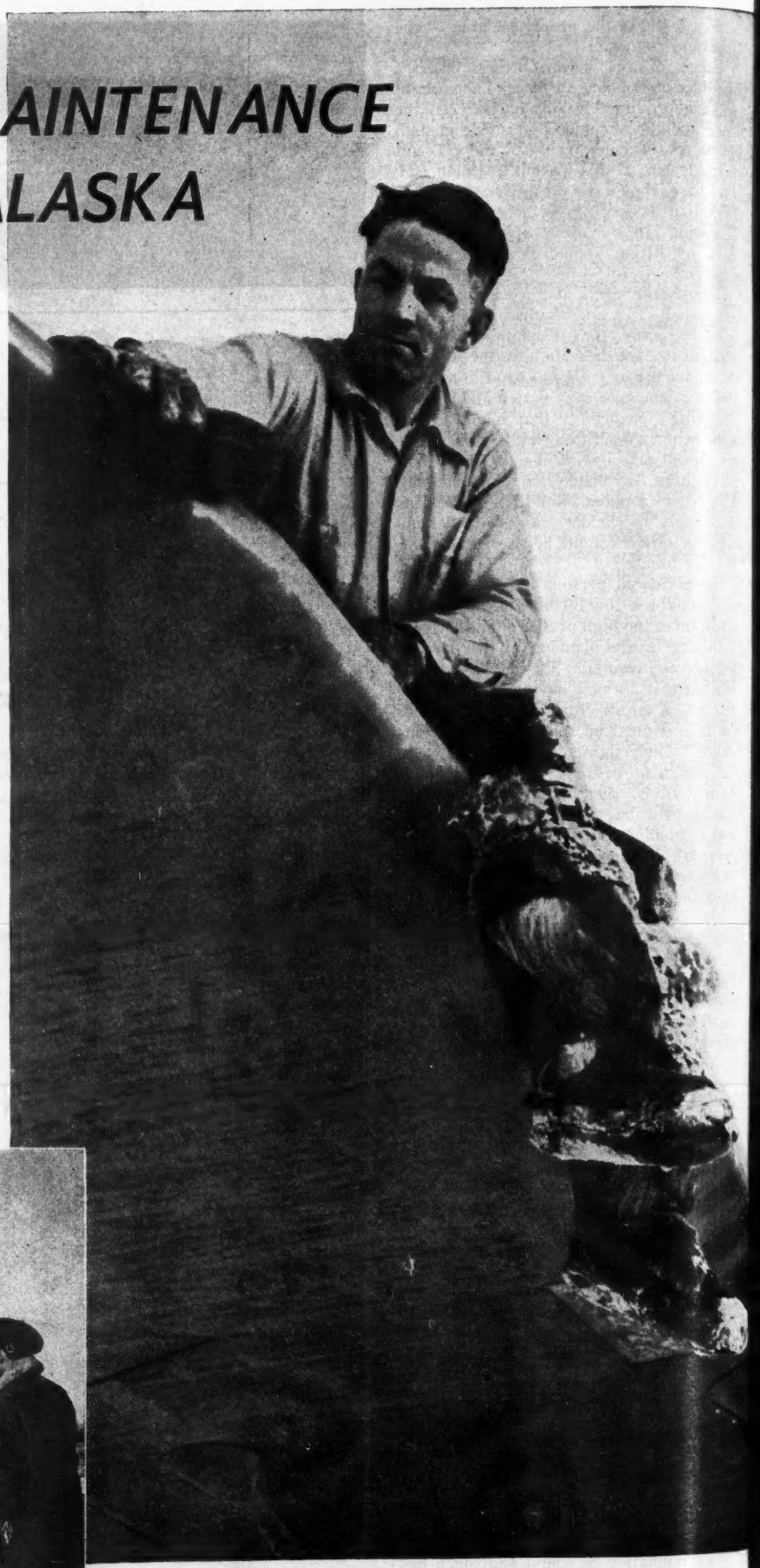
WINTER MAINTENANCE IN ALASKA

By C. O. CARY,
Supt. of Operations, Alaska Star Airlines

Six thousand airline miles at thirty below zero "on top of the world" takes much maintenance and even more grit and ingenuity

"THE LAND OF THE FROZEN NORTH" is a misnomer if you are thinking of Alaska. Actually, it is a country of a wide variety of climates and terrain. There are several distinct regions where different climates prevail. Southeastern Alaska is comparatively mild with frequent precipitation and low cloud conditions where it seldom goes below freezing. In the western coastal district, which includes Anchorage, Kodiak, and the Cook Inlet area, the temperatures in the winter will sometimes go to 30 deg. below, and in the summer to 80 deg. above, but most frequently the climate more closely resembles New York State than it does the popular conception of the Arctic. The third region, which is referred to as the Interior, is on the other side of the coastal range of mountains and here the proverbial clear cold winters usually prevail. The temperature

At Anchorage. "Firepotting" a Pilgrim on the ice.



Mechanic Morgan Davies removes frost from wings of a Bellanca Skyrocket at Bethel.

drops to 50 deg. below in the winter and rises to 90 deg. above in the summer.

An airline which covers Alaska must necessarily be prepared to encounter any of these varying temperature ranges and plan not only for normal operations in these regions, but also for repair, overhaul and maintenance of the aircraft.

It is always difficult to generalize and make a specific statement regarding any subject. Perhaps the one statement which may best be true of winter airline maintenance in Alaska is that "it ain't so". Prior to the war no special surveys or studies of cold weather operation had been made, no Arctic labs existed and operator's success or failure usually was in direct proportion to the experience which he had had in northern flying.

The bush pilots who maintained their own aircraft, or sometimes went "ritzy" and carried a mechanic, devised their own preheating systems and methods of warming their planes after spending the night at some roadhouse in the Arctic. (A roadhouse to the uninitiated, is a combination restaurant, grocery store, bar and hotel, which were originally located every twenty miles along dog team routes.) One of the bush pilot's original problems was his failure to note that water in the gas would freeze in the fuel lines, plus the ordinary troubles that water normally gives. A chamois is still standard equipment on all aircraft in the north because just when and where gas or fuel may be taken on is not always certain.

Another "must" is to drain the oil immediately a plane is stopped if you plan to be on the ground for more than a half hour, otherwise you will have solid oil chunks imbedded in your lines until spring and the first thaw.

Of course, preheating with a blow torch is not unknown, but today the "firepot" is the most widely accepted means of warming aircraft engines preparatory to a winter takeoff. This means that the pilot, or mechanic—or usually both, must arise in one of the early and usually dark hours of the morning before the passengers are up, and go out to the airplane and place a fire-pot, which is merely a heater which burns gasoline with a hot flame, underneath the canvas tarp which surrounds the engine and drops around in a chimney-like form to the heater. This is allowed to heat the exhaust and oil lines for an indefinite length of time varying with the minimum temperature. It is an especially neat trick on an open field with a surface wind of about thirty miles an hour as a tarpaulin is not necessarily fireproof, and planes have been known to burn quite rapidly as a result of the fire-potting process.

The war brought a new development known as a "jeep" heater, which is actually a G.I. version of the mechanical preheaters which operate on gasoline and blow an astronomical number of b.t.u.'s into the atmosphere.

Of course, if you have a hangar all of this is eliminated, but many Alaskan fliers were prejudiced to hangars until very recently.

Another recent addition to flying was the oil dilution system which eliminates fire-potting except in very cold weather. Although the scientific approach to dilution is recent, bush pilots have developed a system of their own which involved using a popular brand of cleaning fluid. The effect on the engines was not particularly desirable however.

Today modern airline operation in Alaska entails many ingenious developments on the part of the operators and the maintenance personnel. Despite priority systems, parts are still many weeks away in the States unless flown by air and it is impractical sometimes to transport them in this manner due to the necessity of vital war materials coming to the territory. The result is that mechanics and machinists have developed many little gadgets of their own, and also manufacture tools when the occasion arises. I even know of one outfit which used to borrow every tool that it could lay its hands on, make a drawing while it was borrowed, and later blossom out with a similar tool of its own manufacture.

There is absolutely no doubt that it is easier to work on a plane when it is in a heated hangar than when it is sitting on a bleak airport at a temperature of 40 deg. below zero. Nevertheless, work on the line must be done and one of the tricks used is to heat the parts (that would not be affected by heat) and wearing heavy gloves use the heated parts to help warm the mechanic's hands while performing his work. In this way a heated bolt or nut could be let go of when the

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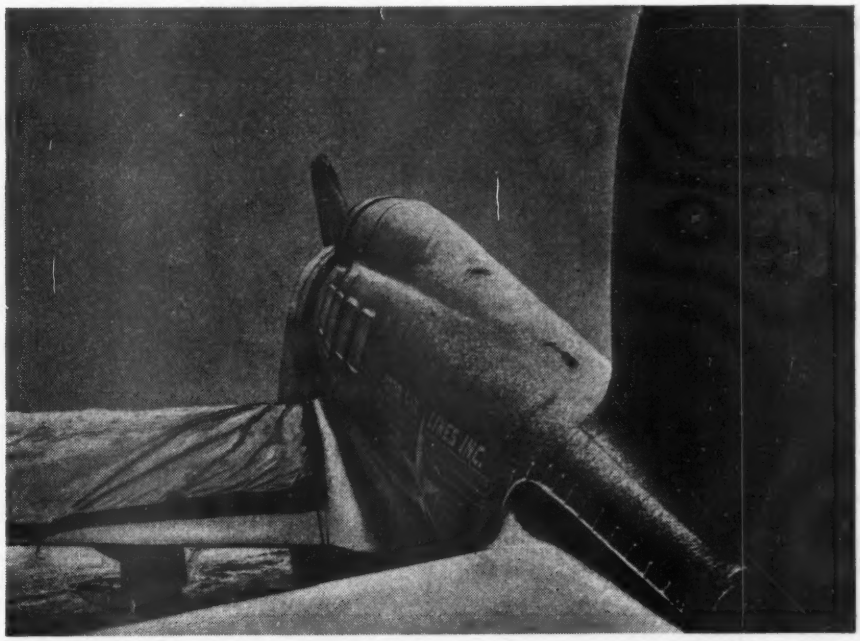
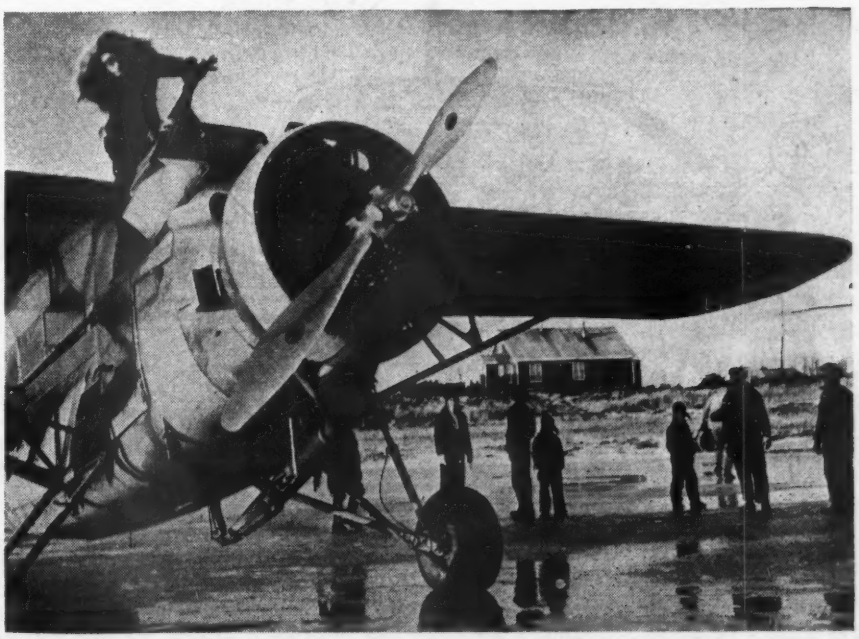


Wing covers against frost are routine for this Orion at Fairbanks.



Pilot "Bud" Brown lands on wet ice at Nome.

PREVENTIVE MAINTENANCE KEEPS MOTORS YOUNG

By R. H. WRIGHT, *Industrial Engineer, Aviation section, and*
W. W. McCULLOUGH, *Maintenance Engineer, Westinghouse Electric and Mfg. Co.*

Once in operation, even the best electric motor is no better than its maintenance man, as this article demonstrates, detailing approved methods for prolonging life of these essential accessories either in aircraft or factory.

THE IDEAL motor maintenance program aims at prevention of breakdowns rather than their repair, and involves competent, periodic and systematic inspection. Records must be kept consistently on the schedule selected.

It is impossible to give any hard and fast rules for frequency of inspection. The following suggestions are based on average conditions.

Every 50 hr. check oil bearings. Check temperature of motor bearings and primary iron with the hand. Sniff the warm air coming from open motors. The fumes emanating from over-heated insulation are unmistakable.

After 100 hr. running, check the brush holders, brushes and shunts of d.c. motors. Blow out the motor with compressed air.

At airplane or engine overhaul check air gap with feeler gauge. Check insulation resistance with Megger. Check line voltage with voltmeter, and load with ammeter. Clean out and replace grease in ball or roller bearings. Check renewal parts stock in light of past experience. Dismantle the motor. See that all windings are tight. Replace loose wedges and loose bands before dipping in varnish and baking. Inspect commutators and commutator connections. Sleeve bearings require no flushing. Remove the bracket and wash out bearing housing. Use hot kerosene and compressed air.

Bearings probably cause more shutdowns than any other part. This is not surprising, when it is remembered that they are victims of misalignment, vibration, thrust, dirt, under, over, or wrong lubrication. All this in addition to their real job of supporting a rapidly revolving part.

The first requirement of successful bearing operation is lubrication. This entails more than just an adequate supply of lubricant; the lubricant, the bearing design, and its condition, must be correct.

Sleeve bearings sustain the oil film to prevent contact between the shaft and the bearing surface. Properly designed bearings have adequate area for the load, proper oil grooving, working oil rings, and suitable materials.

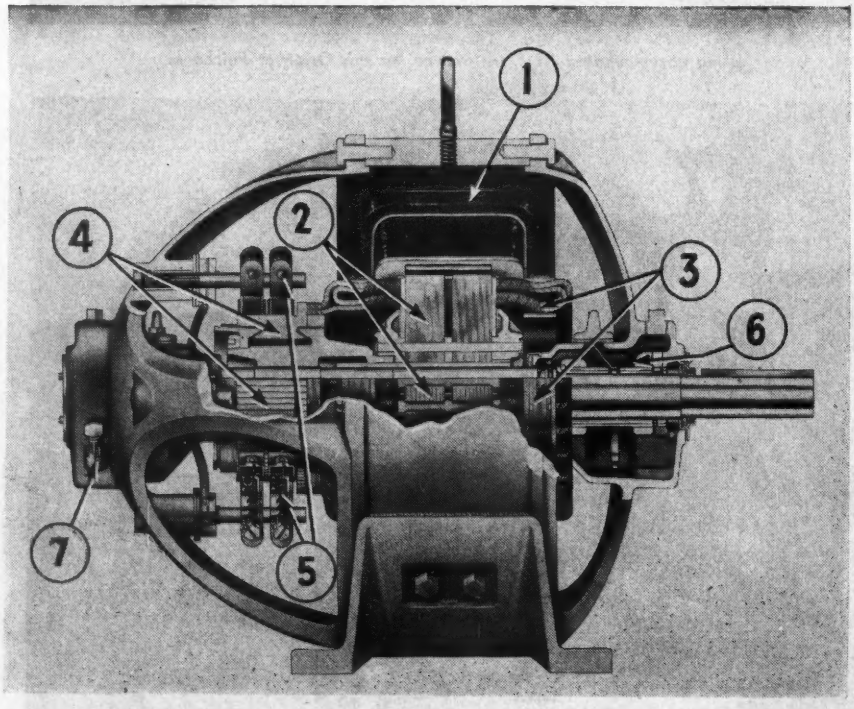
Safe operating temperature for bearings under normal operating conditions is considered to be 40 deg. C rise above the surrounding room air. Assuming proper mechanical condition of the bearing, whether sleeve or ball, and if proper lubricants are used, temperatures above this point call for immediate investigation.

In a sleeve bearing the oil is dragged round to form a wedge-shaped film between the shaft and the bearing which carries the load, and prevents metal-to-metal contact. So long as this film is maintained there is no perciptible bearing wear. To insure the existence of the oil film once rotation has begun, use the right oil. New oil should be added only when the motor is at rest. Oiling of bearings is more often overdone than underdone. Sleeve bearings which require frequent refilling and thereby leak oil onto the windings should be replaced.

The purpose of the felt washer in bearing seals is often misunderstood. The real purpose of the felt is to keep out air and dirt. In itself it has little value for preventing leakage of oil once it becomes oil soaked. Bearing wear, which means radial movement of the shaft, spoils the effectiveness of the bearing seals. Replace all felt seals at the same time when replacing bearings. If it is necessary to make them in an emergency, use high-grade felt not less than ¼ in. thick before compression. Make inside diameter of washer the same as shaft or slightly less. Cut the felt with edges at right angles to surface.

Oil leakage is generally aggravated by high temperatures. Keep bearings cool and use an oil that does not foam easily.

Ball bearings have become increasingly important with the use of totally inclosed and fan-cooled motors. In a sleeve bearing, as just explained, the shaft when in motion is separated from the bearing by the oil film. In a ball bearing, a series of steel balls act as the separating



Cutaway view of d.c. motor. Field coils are shown at 1; 2 is armature; 3, armature coils; 4, commutator; 5, brush rigging; 6, sleeve bearing; 7, oil overflow and filler plug.

medium, both when the motor is stationary and when it is running.

To keep the steel balls uniformly distributed around the bearing a cage or retainer is used, each ball having its own pocket. The balls have rolling contact with the raceway, and sliding contact with surfaces of the retainer. This means that lubrication is necessary.

Most ball bearings used in horizontal motors are grease lubricated although some vertical motors use oil. Follow advice of the manufacturer in selecting a suitable grease. Carelessness in allowing containers to remain open often causes trouble from abrasive dirt. Soda-base soap greases are usually preferred for their high melting point and stability. They mix readily with water, however, and tend to form an emulsion.

Ball bearings in distress can usually be detected by undue heating or by unusual noise. Broken or nicked balls cause rapid destruction of the bearing. They can be detected by the "clicks".

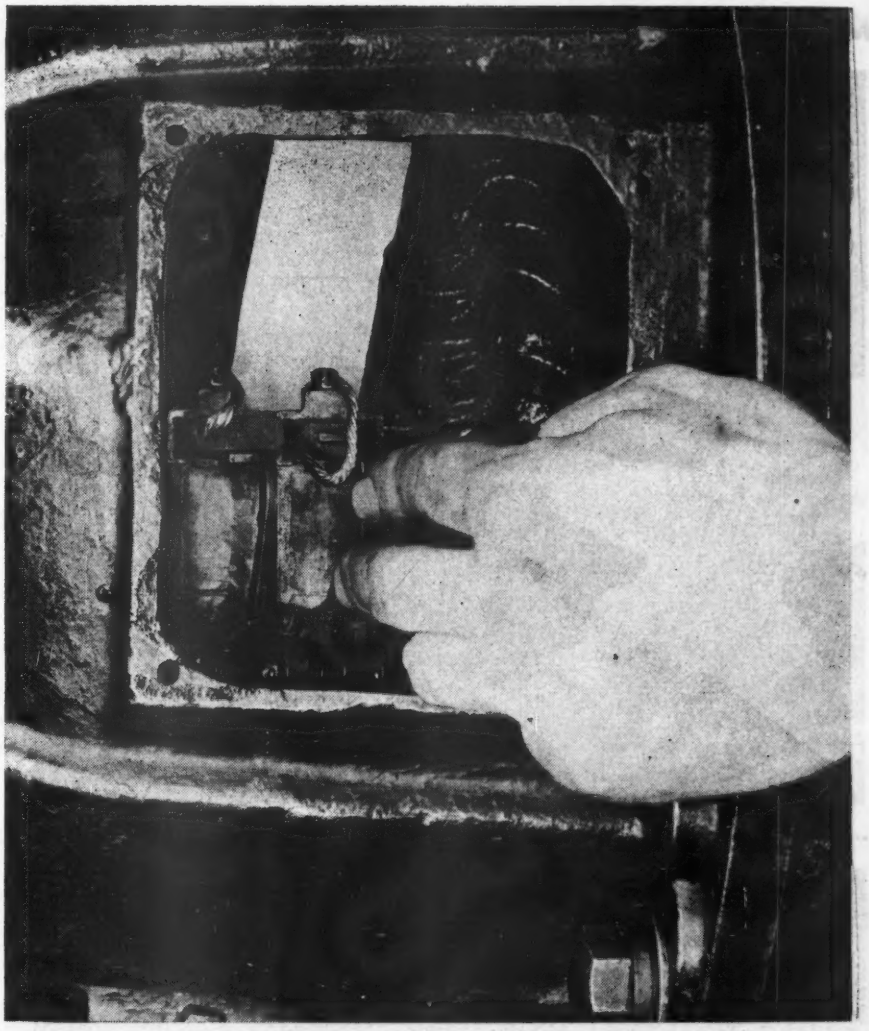
If the specified air temperature rise is exceeded, look for an overfilled bearing, since the first result of over-greasing is heating caused by churning of the grease. The general rule is that the housing should not be over half full. Clean old grease from bearing and housing at every overhaul period, and replace it with new grease.

After the machine is dismantled, bearing should be carefully wrapped in clean cloth or paper to protect it from outside dirt. Remove all old grease from the housing and clean housing and bearing either in Stoddard solvent or carbon tetrachloride. This is a difficult operation because particles of grit are not soluble and are removed with difficulty. Remove final residue of cleaning medium with a light oil before refilling with grease. Fresh grease must be carefully protected from dirt. Keep the cover on tight. Use a clean, nonmetallic paddle for applying the fresh grease.

The air gap in a motor is dependent first on proper maintenance of bearings and second on proper alignment of brackets with the frame. Alternating-current motors operate with less gap than direct-current units, and are therefore more critical. Check the air gap with a feeler gauge at the scheduled period. Make these checks at the drive end, taking 4 readings on each motor, 90 deg. apart. A minimum gap of 0.005 in. should be maintained.

Where coupled motors are used, the couplings require regular inspection. Faulty alignment in a solid coupling is reflected in bearing trouble and vibration. Make sure that all dowel pins are in correct position and check faces of couplings with a feeler gauge after the bolts have been removed. Shift motor position to make the faces of the half couplings parallel.

Flexible couplings will operate under severe misalignment without causing trouble; however, the two halves should be checked with a steel scale to make sure they correctly connected. Any misalignment means increased wear on pins, fingers, or disks, whichever may be used.



Proper method of surfacing brushes is to insert fine sand paper between brush and commutator, pressing brush against moving paper. Firm contact with commutator should be maintained to prevent rounding of brush corners.

Special couplings should be checked according to the manufacturer's instructions.

The importance of keeping electrical equipment clean and dry is worth stressing. Accumulations of dust and dirt not only contribute to insulation breakdown, but they operate to increase the motor temperature through restrictions of ventilation. Dust and dirt are effectively removed with compressed air at about 50 psi. Do not direct the air against the insulation until certain that it is free from accumulated moisture in the line. Too great pressure may loosen the binding tape or injure the insulation by sand blasting with the abrasive dirt nearly always present. It may not be possible to remove all dirt by blowing with compressed air. If the accumulation contains oil or grease, a solvent will usually be required to remove it.

There are three types of solvents in general use for this purpose—petroleum distillates, such as Stoddard Solvent or cleaners' naphtha, carbon tetrachloride, and a mixture of the two. Petroleum distillates are solvents having the least corrosive action on insulation and for that reason, are preferable to the others. The Stoddard type solvent, produced by all major oil companies, with a minimum flash point of 100 deg. F, minimizes fire hazard, and should be used in preference to gasoline or benzene.

When the above solvent will not properly clean the apparatus, a mixture of carbon tetrachloride and solvent may be used. A mixture of 50 percent carbon tetrachloride and 50 percent Stoddard solvent is noninflammable, but the vapors mixed with a right proportion of air are explosive. In extreme cases it may be necessary to use straight carbon tetrachloride. When used, the toxic effect of this material on the operator must be taken into consideration.

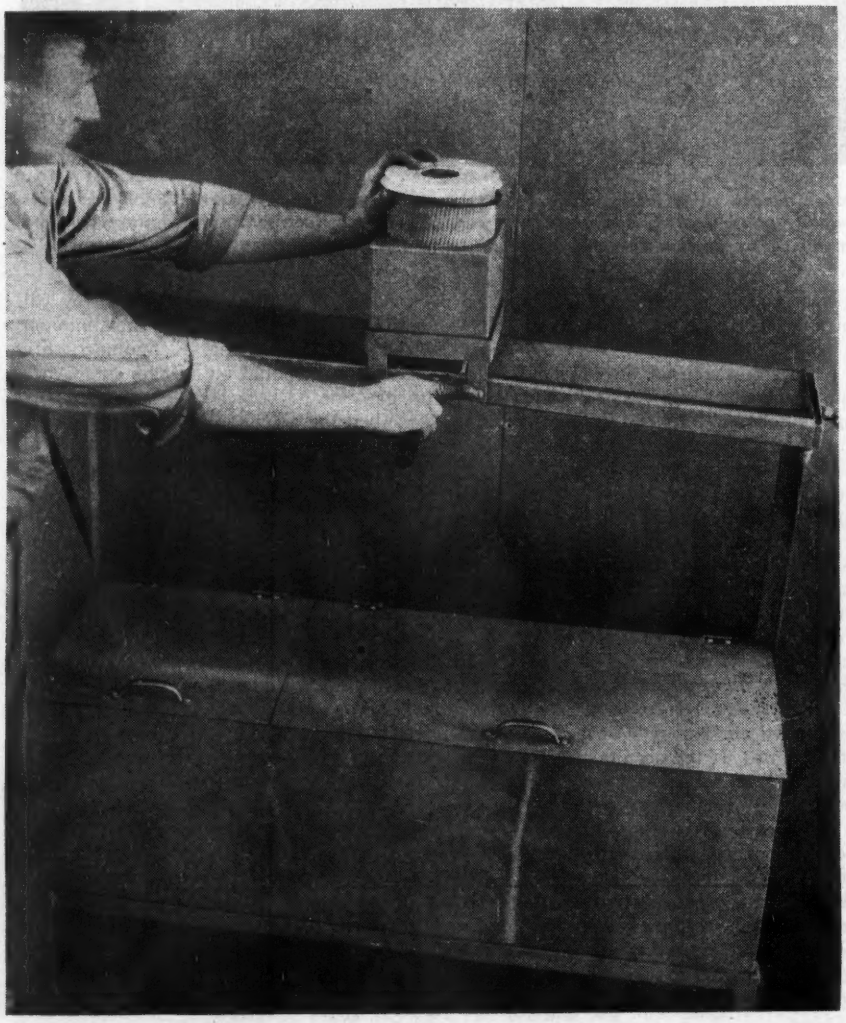
Carbon tetrachloride is more corrosive in its action than petroleum solvents, and it evaporates much more rapidly. For this reason the residue of carbon tetrachloride should be removed by applying a petroleum solvent to prevent corrosion later on.

Before any solvent is used, be sure that there is good ventilation and minimum fire risk. Do not let workers' clothing become saturated with the solvent. Always have carbon tetrachloride fire

(Turn to page 249)

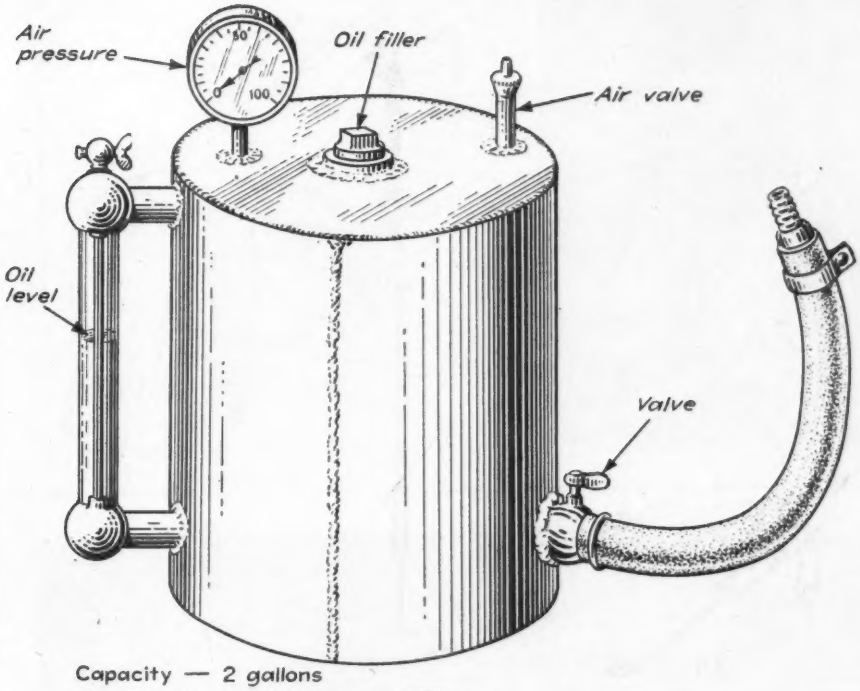
Sparkplug Tester

• This compact sparkplug tester shoots 6,000 volts through over 8,000 plugs per month at United Air Lines' Cheyenne base. This test is one of many operations in reconditioning and inspecting sparkplugs.



Embry-Riddle's Filter Cleaner

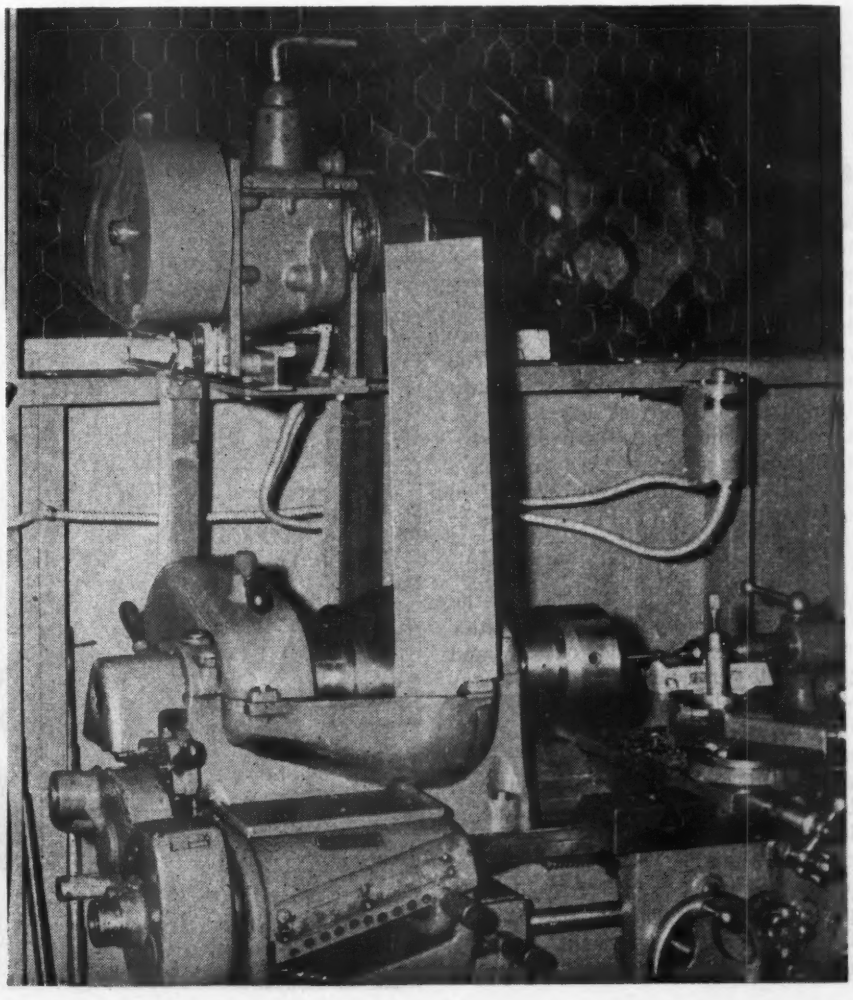
• S. R. Monschke, maintenance supervisor for Embry-Riddle at Hawthorne Field designed this filter cleaner which has two naphtha wells and an oil tank in base. Rotary blower is at top on which filters are held by hand while air is forced through fabric. Liquid drains from top trough down into tank at bottom.



Capacity — 2 gallons
Construction — Welded of 0.125" steel

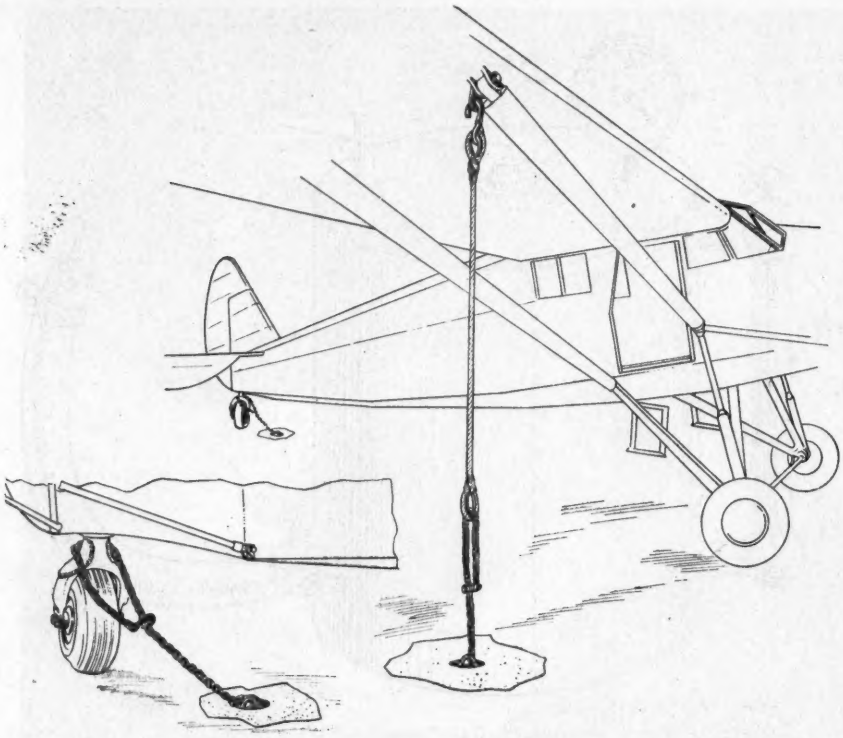
National Airlines Pre-Oiler

• Filled and pressured in the hangar, this handy pre-oiler can be taken to any part of the airfield in a sidecar. Contents may be safely heated by using a blowtorch or any other convenient means, since it has no finish or delicate parts which might be damaged by "rugged" treatment.



Ford Transmission Makes Useful Lathe Speed Changer

• Side-stepping the shortage in machine tool equipment All American Aviation at Pittsburgh used a Ford gearbox as a lathe speed-change gear. Bracket bolted to front of case carries bearing for motor drive, while lathe belt drive pulley fits where universal joint formerly was placed. Gear shift handle extension is bent within convenient reach of operator.

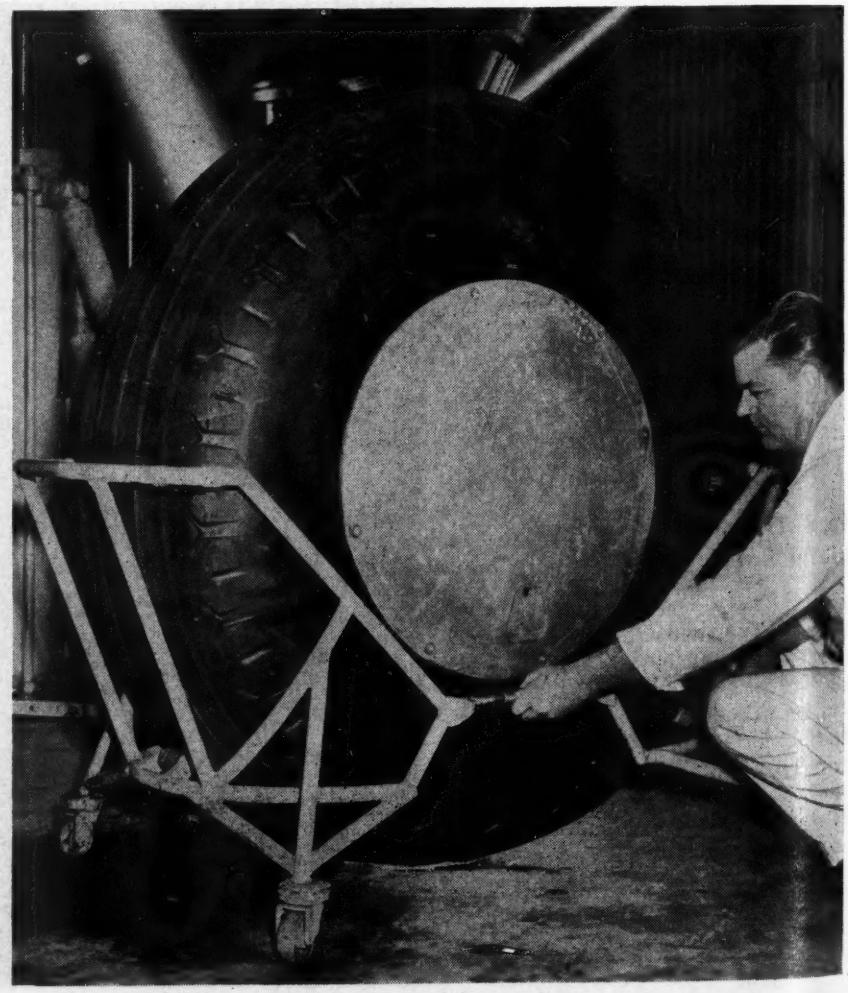


Novel Anchorage Adjustment

• Trainers "on the line" at Roscoe Turner's school at Indianapolis Municipal Airport must be fastened down in a hurry or they may be blown against one another by the backwash of AAF bombers taking off a few yards away. To save time and yet have secure fastening, easily adjusted to almost any small or medium plane, ordinary logging chain is used, the "grab hook" providing a fast and strong anchorage to cement blocks buried three feet in the ground. Insert shows means of allowing slight play at tail wheel to prevent straining wings or fuselage.

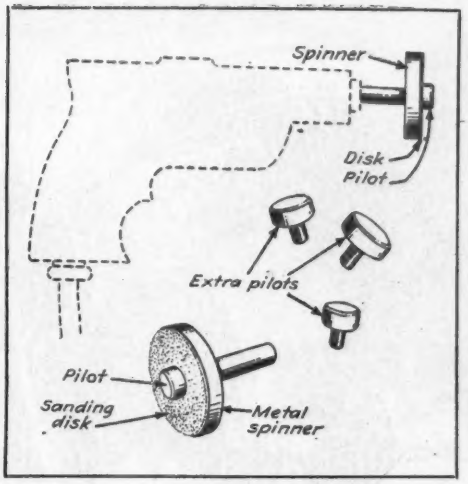
Pan American Tire Dolly

• Wheels of transport planes operated by Pan American Airways are so large that they have presented difficult handling problems. These are simplified, however, by applying this two-piece dolly made from welded tubing. The two units are light and easy to push into place after a jack has lifted the tire off the floor. As both dolly sections are on casters, they do not have to be lifted. When in place, the two turnbuckles pivoted to the dolly, one at each side of the tire, draw the two halves together. Once the wheel hub is disconnected from the spindle and the tire is supported by the dolly, the latter with its load can be rolled outward and pushed to any point in the hangar without any lifting. After any servicing needed is completed, the dolly is used to return the wheel with tire in place to the plane and to push the wheel back onto its spindle. By tightening or loosening the turnbuckles, the wheel can be raised or lowered the precise amount required to push it easily into place. Disengagement of the dolly from the tire is even easier than the initial application.



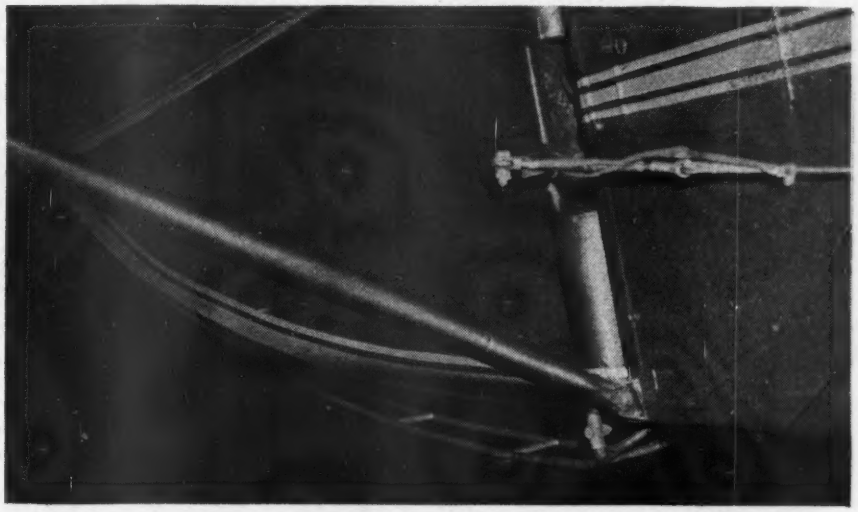
Interchangeable Pilot And Disk Holder

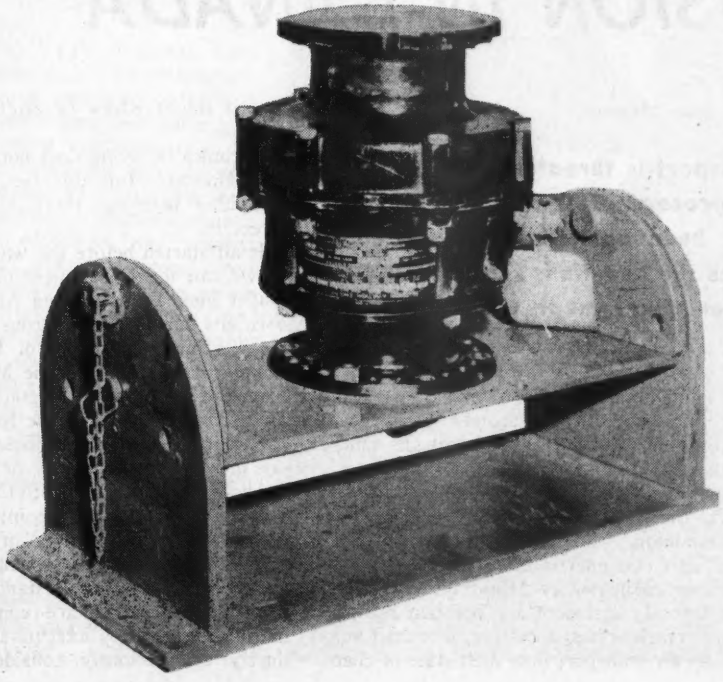
• George Stewart of Curtiss-Wright's Columbus plant devised this tool for removing anodize and paint finish from around holes for bonding. Use of the device saved two-thirds of time formerly required. In operation pilot is selected to fit hole and sandpaper disk fitted to spinner. Used in electric drill, tool cleans surface rapidly and more evenly than by old hand method. Tubes with sharpened edges are used to cut disks from sheet sandpaper or emery. Photo shows George Stewart holding his invention.



Rudder Guard Prevents Damage

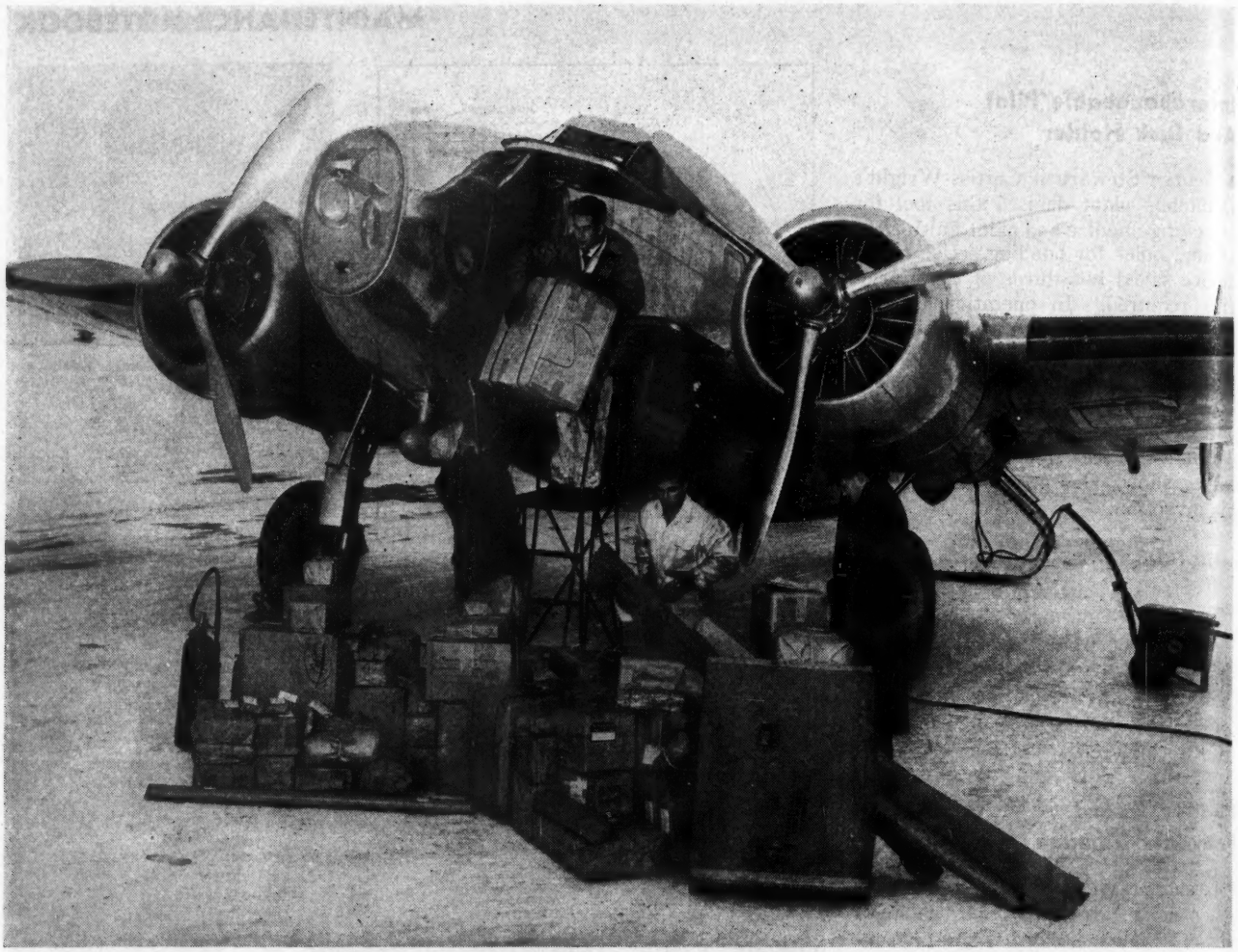
• Designed to protect the rudders of its "pickup" planes from damage, this attachment, welded from 4130 tubing, was made by All American Aviation at its Pittsburgh shops. The device would be useful on airfields where there is brush which might cause damage to rudder fabric.





Embry-Riddle's Starter Stand

• Swinging about the center of gravity of the starter and locked in any of three positions by the pin shown at left side, this stand enables work to be done without risk of personal injury to the mechanic or damage to the mechanism.



Loading freight in Canadian Pacific Air Lines Lockheed "Lodestar." CPA, which took over many "bush lines," flew 10,000,000 lb. of air freight in 1942, but under one-man control now in force in Canada, states author, entire operations are threatened.

CONFUSION IN CANADA

By KEITH EDGAR, *Associate Editor, "Canadian Aviation"*

Very existence of Dominion air transport is threatened by one-man control, states Mr. Edgar, and he proceeds to detail the facts as he finds them. These pages have been opened to the author's opinions because AVIATION believes the questions thus highlighted invite careful consideration by other governments and operators.

CANADA'S PRESENT TRANSPORT Aviation status offers an object lesson to every government, every transport operator, every potential transport operator.

It is an object lesson proving conclusively that one-man control—no matter how efficient, how beneficent—is *not* suitable for air transport development.

For an outsider attempting to grope through the uneasy swirling fog that envelops Canadian flying, it is disconcerting to find that at every turn the path leads to but one man; the answer to any question hangs there in the balance unless this one man has endorsed it; one man is in complete and absolute charge of the far-flung air transport routes of the Dominion.

This one man is the Hon. Clarence D. Howe, Minister of Munitions & Supply. Obviously a sincere and brilliant man, he nevertheless has, I believe, thrown Canadian air transport into such state of chaos that it might easily be on the brink of collapse.

Technically, flying does not come under the Minister. But this fact, apparently, is neither here nor there. For he does direct it.

It all started before the war, when Mr. Howe ran the Department of Transport. Under him, Trans-Canada Air Lines was born and nursed into vigorous life. When the wartime Department of Munitions & Supply was created, Prime Minister McKenzie King picked Massachusetts-born Howe to run it. That he has done this job with the greatest of efficiency, that no one questions his sincerity or ability, that he has worked wonders with Canadian war production is beside the point. The minister has refused to let go of TCA.

It is necessary to delve into the background of TCA to understand why today Canadian operators are completely demoralized, why top executives of the industry are seriously considering offers

CPA and predecessor bush lines are credited with serving four-fifths of Canadian territory, offering only available transport connection (other than dog sled and canoe) with many points. Under present set-up, says Mr. Edgar, government-owned lines may take over entire area without regard to pioneering work done by small lines and independent operators.

made by United States airlines, why the picture in Canada is gloomy indeed.

In the first place, Trans-Canada Air Lines is government owned, through Canadian National Railways. The latter company—which is, after all, the government—put up the initial capital, some $5,000,000. The government built the airway at a cost, up to the outbreak of war, of approximately $18,000,000, and it provides a mail contract subsidy.

TCA was set up strictly as a coast-to-coast trunk line, striking across Canada via the main population centers as a modern, efficient, and smooth-running airline with the latest equipment and a high performance record.

But, actually, TCA serves a very small section of Canada. For bush pilots, operating on floats in summer and skiis in winter, had built up a vast network of operations over the forest land and tundra that provided four-fifths of the nation with its only transport except for dog team and canoe, and which had hauled more air freight than had ever been carried by any country in the world.

These operations ranged from scheduled services with twin-engine equipment to services in which a pilot, informed over the radio by his dispatcher that passengers or freight were waiting at such and such a place, simply flew there and picked them up.

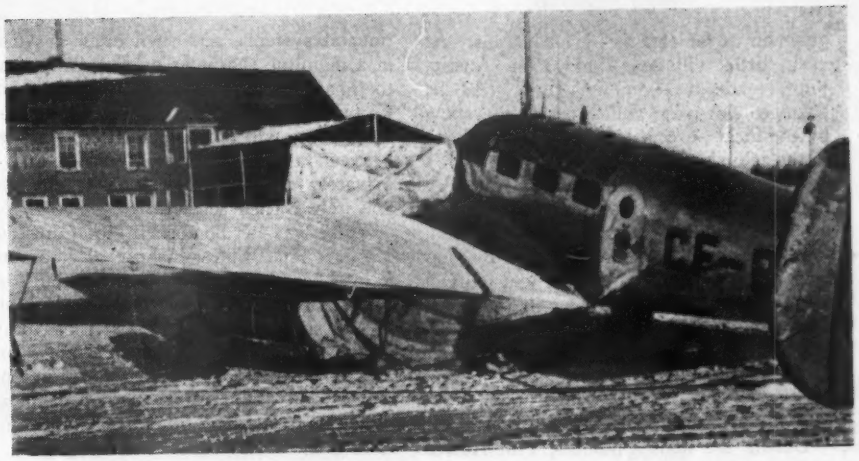
The war hit these bush pilots hard. Mining and trapping operations were curtailed, some left to join the service, equipment became virtually impossible to obtain.

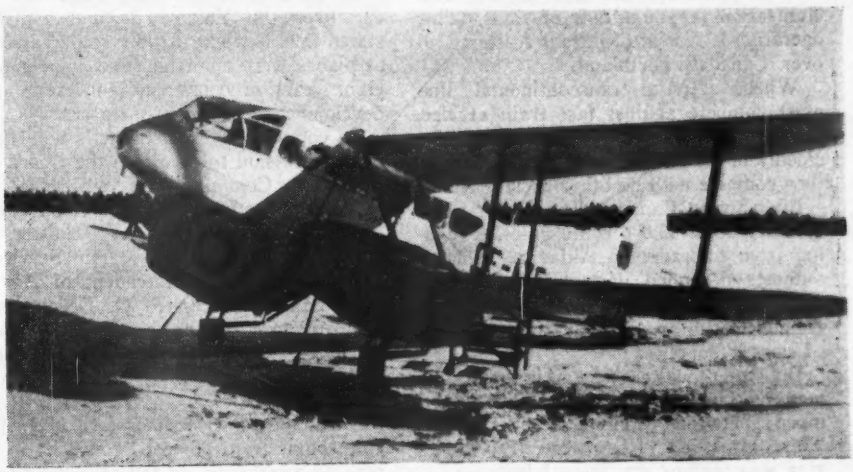
Then Canadian Pacific Railroad, Canada's only privately-owned transcontinental system, purchased many of the bush lines, absorbed their personnel under permanent employment contracts, and set about to get the most out of more than $5,000,000 investment by attempting to tie the scattered lines into a unified system.

Modern radio equipment was installed, dispatching and control systems were organized, and up-to-date airline operations were introduced—often the hard way in the view of many of the old-time pilots who had operated on the rule-of-thumb lake-to-lake method.

But even today the operations of TCA and CPA are as different as night and day. While TCA is comparable to any of the larger U. S. lines, CPA is like nothing else on earth.

Recently, for example, the writer spent a day with one CPA pilot operating out of Baie Comeau, on the north shore of the Gulf of St. Lawrence. Starting shortly after dawn with a load of mail, our eight-year-old deHavilland *Rapide* acted as





Vast areas of territory were given reliable, fast communication throughout year by bush lines, which operated such equipment as deHavilland "Rapide" (above). Typical of winter mail delivery pioneered by these lines is "bombing run" technique, in which mail sack is tossed through chute in plane (below) near flag staked out by postmaster. Canadian Pacific Air Lines, now reported threatened by government air transport monopoly, merged many such lines into one integrated system. (All photos courtesy "Canadian Aviation")

postman as far east as Seven Islands. At each little village, Capt. Phil Austin, pilot, made a "bombing run". As he swooped down on a flag set in the snow by the local postmaster, his assistant back in the cabin popped the mail bag through a hatch, spotting it near the flag. Six hundred pounds of mail were thus delivered without the plane having to land. Outgoing mail was transported by dog team to the nearest "airport"—usually a postage-stamp sized clearing in the bush, often only a lake.

The rest of the day was spent shuttling from settlement to settlement—mostly paper and pulp mill set-ups—picking up and discharging passengers and express.

During the winter months, Phil Austin and his plane are the only contact with civilization for thousands of souls. This operation is typical of dozens scattered all over Canada's northland.

Where TCA's transcontinental line must compete against fast train service, the sprawling operations of CPA are decidedly in the class of an essential service; they compete with no other surface traffic.

By last year, Canadian Pacific Air Lines operated some 12,000 route miles, extending from Labrador to Aklavik. Isolated outposts depended upon CPA for their mail, for their communication with the outside world, and for fast transportation of urgent supplies.

But—there was a long gap in the system between Quebec City and Kenora-Winnipeg, between Winnipeg and Regina. This sprawling Northwest Territories area was without continental hookups.

Naturally, CPA hoped to integrate the system over a northern route which would not compete with TCA's mainline run. But it wasn't that simple. For on Apr. 2, 1943, the Prime Minister announced in Parliament that:

"Within Canada, Trans-Canada Air Lines will continue to operate all transcontinental systems, and such other services of a mainline character as may from time to time be designated by the government. Competition between services over the same route will not be permitted, whether between a publicly owned service and a privately owned service or between two privately owned services."

This was a bombshell to Canadian Pacific Air Lines, whose Edmonton-Whitehorse-Yukon route had been built up into a route of "mainline character". This meant, simply, that the Minister of Munitions & Supply could, after private operators had built bush lines into paying propositions, simply designate them as "services of a mainline character"—and take them over.

By January of this year, TCA cast its eye over the Yukon run and actually stated that it would fly the route as soon as planes were available, thus wiping out eight years of consistent pioneering and development by private operators.

So complete is the Minister's hold that he may be said to dominate the Board of Transport Commissioners, whose job it was to allocate franchises. Three members of this board, the Deputy Minister of Transport, the Director of Air Services, and the Chief Superintendent of Air & Land Mail Services, P. O. Department, are directors of the government-owned TCA. Yet they exerted direct control over issuance of licenses to private operators.

Thus, if you wished to start an airline from point A to point B, you had, when making application, to tell all your plans, your resources, and your equipment to your biggest competitor.

If TCA considered that some day it might want to run over that route, or if your application made it plain that such a route might be profitable, your chances of getting either a license or a mail contract were just about nil. More than once has TCA expressed an interest in a potential route *after* CPA first sought the franchise to fly it.

An interesting example of the power of the minister concerns the New York run. When inauguration of the Toronto-New York service of TCA was being arranged, the points to be served had been officially named under order-in-council (equivalent to a U.S. executive order), and the Board of Transport Commissioners prepared to hold hearings which would allow other lines to enter proposals.

Then, on June 17, 1941, the route was suddenly "unnamed" by a new order-in-council.

The run has since been maintained without having been passed upon by the Board, under international agreement alone. The government, rather than the regulatory body, passed upon the creation of this route. The same holds true as to certain lines operating in Maritime defense zones.

The situation has gone from bad to worse, as far as private enterprise is concerned; for two months ago the Minister announced that railways must divest themselves of ownership of airlines within one year after the ending of the European war. This was a blow which still has private operators reeling and groggy.

The Minister, to offer evidence that this is not discrimination, pointed out that TCA was also railway-owned. But to divest TCA of railway ownership merely means removing four CNR directors and replacing them with government appointees. The government will still be the actual owner of the airline.

For CPA, this means the collapse of the airline—12,000 route miles. There are no possible purchasers in Canada who would be willing to take over the complete set-up under present conditions, with no hope of a transcontinental hook-up.

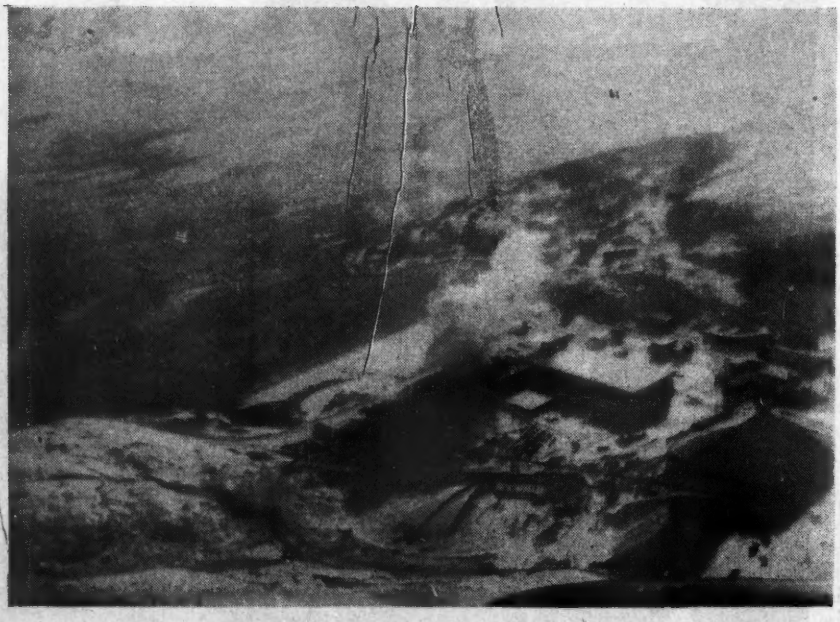
Canadian Pacific Railways, with Canadian Pacific Steamship Lines, is a world-wide organization, respected and reasonably prosperous. So far in this war, it has lost at least a dozen crack liners, among them the *Empress of Britain*. Including freighters, two-thirds of the fleet has been lost in war service. Early in the war, Canadian Pacific Air Lines helped develop a trans-Atlantic air ferry service, which has since been taken over by the RCAF.

Besides the transport lines, CPA has been training observers for the RCAF in several schools, and it has done a magnificent job, as all official sources will willingly testify. These schools are operated on a non-profit basis for the government. In addition the organization also does a great deal of repair work on RCAF equipment.

Altogether, CPA is a 7,000-employee operator, internationally respected—the U. S. Government has accepted its operations with whole-hearted appreciation in the north country.

It would seem natural, therefore, that such a company, with such an exceptionally creditable contribution to the war cause, should be given some consideration in a postwar readjustment.

(*Turn to page* 256)



Typical pulp mill community, which has come to depend on CPA for outside communications the year round. North country flyers operate on floats in summer, on skiis in winter.

The B.F. Goodrich Airliner of the month

TWA'S CONSTELLATION

WHEN TWA'S NEW 40-ton land giant lighted at Washington Airport less than seven hours after leaving a West Coast runway, all America had a preview of things to come in commercial transportation.

TWA has turned the Constellation over to Uncle Sam. Soon, instead of carrying 57 civilian passengers, it may be speeding up to 100 fully equipped soldiers or more than 14 tons of cargo to a war front. When peace comes, this plane and other "Constellations" will become TWA luxury transports spanning the country in less than nine hours or flying from New York to London and other European cities overnight.

Many B. F. Goodrich products fly with the Constellation. Among them are De-Icers which protect her mighty wings and empennage surfaces, and B. F. Goodrich tires and tubes which lessen the shock when her 40-ton bulk comes to earth.

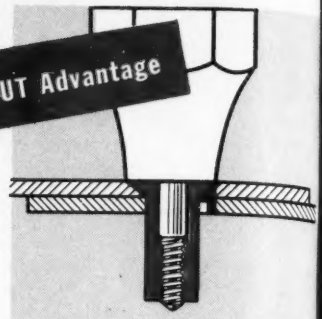
B. F. Goodrich salutes TWA in naming the Constellation this month's "Airliner of the Month."

In war or peace

B.F. Goodrich

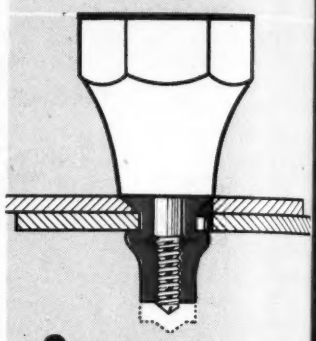
FIRST IN RUBBER

Easy Installation Big RIVNUT Advantage



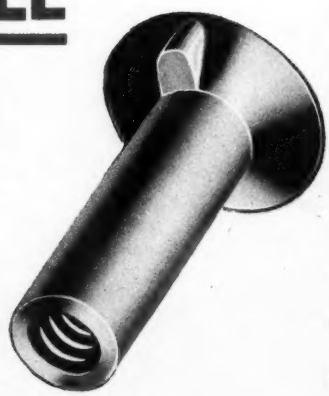
2 Insert Rivnut into hole. When Rivnut with key is used, be sure the key is indexed to enter the keyway previously cut in metal.

1 Thread Rivnut onto "pull-up" stud until head of Rivnut touches anvil of heading tool.

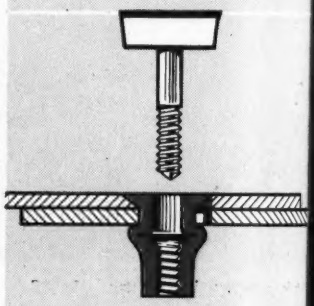


3 With tool at right angle to work, squeeze lever. This retracts "pull-up" stud into tool, which causes counterbored portion to bulge, forming a head against the blind side.

RIVNUT...A SIMPLE BLIND FASTENER!



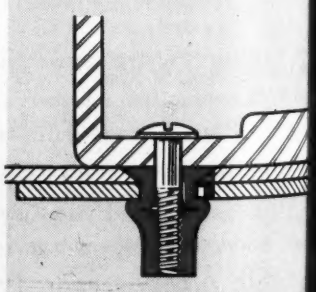
One-piece can be used as blind rivet, as nut plate for attachment . . . or both!



4 Unscrew "pull-up" stud, leaving threads of Rivnut intact and ready for use as a nut plate.

THE B. F. Goodrich Rivnut is a one-piece tubular aluminum rivet with a counterbored, internally threaded shank. It is headed with a simple hand tool while working entirely from one side. A threaded pull-up stud on the tool engages the threads inside the shank, and when slight pressure is applied, a ring type bulge forms on the blind side. This bulge or upset is large enough to resist being pulled through metal or plastic even under conditions of eccentric load. For nut plate use, Rivnuts are available with key for torsion resistance. Rivnuts are strong, light in weight, low in cost. They're ready for use "as received" and fit tight without preliminary refrigeration or other preparation. A full range of standard sizes, types, and grips is available; also plug and accessory screws. If your fastening problem requires a special-purpose Rivnut, B. F. Goodrich engineers will be glad to work out details and designs with you.

Why not get the facts about Rivnuts now? Find out how these *simple* blind fasteners can lick some of the most troublesome attachment problems.



5 Attaching accessory with screw is easy now. Rivnut threads grip screws firmly after upset.

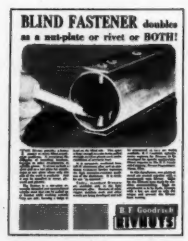
B.F.Goodrich

RIVNUT

IT'S A RIVET...IT'S A NUT PLATE

Awards to 9 plants

NEW... FREE "RIVNUT DATA" BOOKLET



It gives you the whole story, clearly . . . and with pictures. Installation, step-by-step, types, sizes, grip-ranges. For your copy, write to The B. F. Goodrich Company, Dept. 0990, Akron, O.

ASTRALIDADE . . . For Fast Position Finding

Accurate position finding—the key to avigation—is made quick and simple by Georges Estoppey's invention, a device which performs several tedious mathematical problems in a few seconds with mechanical precision.

CHIEF VALUE of the astralidade lies in its rapidity in checking against dead reckoning by one observation on a known star or the sun. A well trained avigator may require less than a minute to find his position within a few minutes of arc. It is only necessary to recognize important stars and know exact Greenwich time.

This instrument also enables determination of true North without computation within less than a minute of arc whenever Polaris is visible, and the magnetic declination can also be determined. The device can be used proficiently by anyone not versed in astronomy who desires to study avigation by means of the asters.

Principle is the same as that of any astronomical telescope, with the main difference that its apparent celestial equator is moveable and can be readily set at any instant according to the latitude. It is a kind of theodolite comprising special scales and a sphere on which are engraved the asters.

The instrument consists of the following: A globe on which are engraved a certain number of stars . . . Date circle comprising a right ascension scale graduated in days and months, to which the globe is fixed and oriented with the vernal equinox . . . Fixed sidereal-hours circle . . . Pivoting table representing the celestial equator, to which sidereal-hours scale is fixed and about which the globe and date circle rotate, and comprising a latitude scale and control . . . Inner altitude ring graduated in degrees rotating into date circle . . . And a sighting telescope with a setting-pointer parallel to the sighting line sliding into altitude circle.

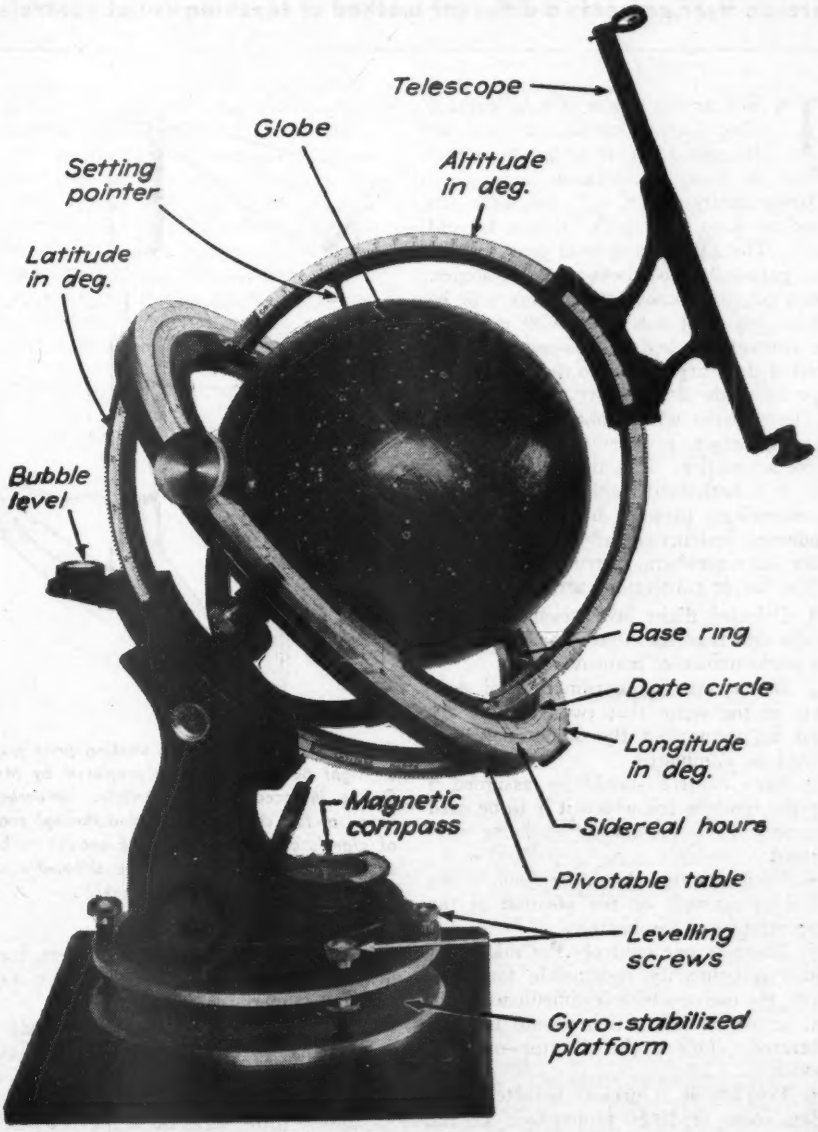
When the pointer on the altitude ring is indexed over the desired star on the instrument's celestial sphere, and the containing ring is then rotated until the star is in the sights, there is only one condition that will permit a sight on this star, that being such an alignment of the hour circle opposite the date in order to give longitude in time on the hour circle (which was moved with the telescope and altitude ring) and to give latitude directly on the latitude ring.

Also, there is a rotating table support, about which the celestial equator pivots around a horizontal axis. Said rotating table comprises bubble levels and level device and a magnetic compass, and it rotates about a stabilized platform.

In addition there is a stabilized platform comprising an azimuth scale—a platform which is stabilized by means of a gyroscopic servo motor system enclosed in a housing fixed to the airplane. Further, there is a plurality of controls, verniers, and a clamping device.

When avigating in the southern hemisphere, the North Pole of the globe can be readily turned over.

As happens with any new device, objections will be raised that the instrument cannot be built to afford the degree of accuracy required to solve the spherical triangle or the degree of accuracy obtained by the use of the sextant, table, and logs. However, the instrument has been tested and its basic principle proved to be correct. To consider the details—



1. Date circle is divided into days and months. Calibration of each date is made according to the speed of translation of the earth along its eliptical ecliptic and therefore the day's graduation is not equally divided around its 360-deg. date circle.

2. Slow movement of the perigee in relation to the vernal point causes a periodic variation to the date scale, but this variation is so small that it is neglected.

3. Another periodical variation, from 0 to 9 min. of arc, is due to mutation. This variation of arc represents an error of

(*Turn to page* 242)

A New Approach To Flight Instruction Technique

By JOHN H. GEISSE, *Civil Aeronautics Administration*

Anticipating a large and divergent crop of flight students, this veteran flyer presents a different method of teaching use of controls.

THIS article might well be entitled "One Man's Opinion on Pilot Instruction," for it is by no means official or even semi-official.

Undoubtedly there will be some instructors who will think "this is all old stuff. The author is several years behind the parade." To them, my apologies. However, it is known that there will be others who will not agree with many of the contentions, and it is hoped they will present their arguments so that correction may be made if necessary.

The remarks which follow are intended to apply only to primary flight instruction —not acrobatics. It is the author's belief that it is both inadvisable and ineffective to complicate primary instruction by introducing instruction whose object is to make later acrobatic instruction easier.

The major contentions are these:

1. Primary flight instruction should be on the effects of the controls and not upon the performance of maneuvers.

2. Instruction in coordination of controls in the sense that two controls are used to accomplish the same maneuver should be eliminated.

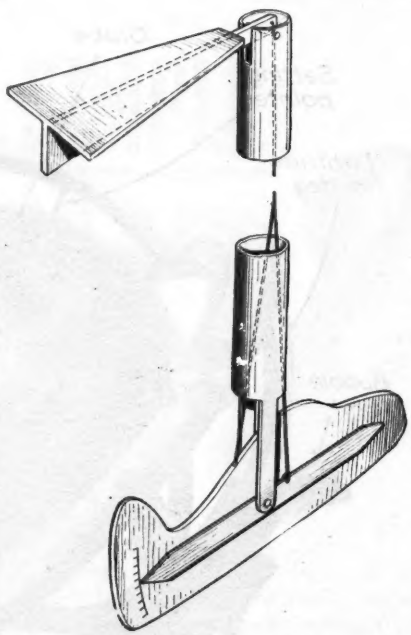
3. Each control should be assigned a specific function for which it is to be used irrespective of the maneuver being performed.

4. No instruction should be given in the effect of controls on the position of the nose relative to the horizon.

5. There is one control—the misuse of which is primarily responsible for accidents, the use of which is difficult to teach, and on which instruction should be concentrated. This is the elevator—not the rudder.

6. Possibly it is useless to attempt to teach some students proper use of the rudder in a turn except by reference to instruments; such individuals should be taught not to use it in turns unless they have an instrument to guide them.

When a pilot has learned what to do with the controls to make the airplane go where and how he wants it to go he will have no trouble performing specified maneuvers. These maneuvers may be a good way to check on the pilot's ability to control the airplane, but even here they lose much of their value if they have been used too much for instruction.



Cut-away drawing showing working principles of flight path indicator as proposed by Mr. Geisse in accompanying article. "Weather vane" at top could be extended through roof of plane's cabin, reaching high enough to be in undisturbed air, with plane silhouette at bottom at about pilot's eye level.

A maneuver is fundamentally simply a fixed sequence of control use. It is not impossible to teach one to perform a set sequence of movements without developing the ability to perform these movements in some other sequence. Take typing as an example. There is one sentence "All good men—" etc., which is commonly used because it has a good distribution of letters. But if one concentrated his practice on this one sequence of letter use, he would be quite unable to type any other sentence without mistakes except by looking for each key. Also, the ability to type this sentence rapidly is a poor indication of the general ability of a typist, because so many have practiced it.

Although the analogy is somewhat far fetched, the elevator might be considered the "A", the rudder the "B", the aileron the "C", and the throttle the "D". Teaching a maneuver is teaching a fixed sequence of use of these letters. Adequate instruction can only be that which teaches the pilot to be able to instantly find and use any of these letters in any sequence, for any sequence may be required in rough air.

Perfect coordination of controls is impossible even for an instrument. Coordination necessarily involves leading with one control to accomplish a desired objective and then moving the other controls to accomplish other objectives. In the turn, for example, the ailerons are used to make the turn in the horizontal plane, the rudder is used to correct for any slip that may develop, and the elevator is used to correct for any resulting change in the path in the vertical plane. Some slip and some movement up or down must manifest itself first to cause the pilot or any instrument to make the required movements of the secondary controls. The only alternative would be to learn just how much and how far to move each control, but this would be mechanical flight which is hardly to be recommended.

Teaching coordination of controls is not unlike teaching maneuvers and again a comparison to typing is possible. It is teaching a sequence of control movements. This is unnecessary if the proper use of each control has been learned. If a pilot has been taught to strike "B" (the rudder) without thinking, whenever slip or skid develop, it will be immaterial to him as to whether "B" is required before or after "C" (Aileron) or without "C".

Control of the path in the horizontal plane should be assigned to the ailerons, control of the path in the vertical plane to the throttle, control of the angle of attack to the elevators, and control of the angle of yaw (skid or slip) to the rudder. This does not mean, however, that the effect of all controls on all functions should not be taught. They should be, but only as secondary, not primary, effects.

Instruction in the proper functions of the rudder and the ailerons has been anything but consistent. Much instruction in this country—including practically all Link training—has been to control the turn with the rudder and control the slip or skid with the ailerons. Instruction in England is exactly the opposite.

Arguments can be presented on both sides. The turn of the airplane is made up of two entirely distinct motions. This may be demonstrated by moving a book on the table. It can be rotated around its center without having the center move. The center can also be made to traverse a circular path without rotating the book around its center. To make it move as the airplane must move these two motions must be combined and the book rotated around its center at such a rate that it will make one complete revolution around this center each time the center makes one complete traverse of its circular course.

In the airplane the rudder sets up the forces necessary to rotate the airplane around its own center and banking the airplane with the ailerons sets up the force necessary to make the center move in a circular path. Hence both can be said to be required for the perfect turn.

However, it has been pointed out that perfect coordination is impossible—one control must lead and the other must follow. The only indicator of how much of the second is required is skid or slip. The second, then, becomes a control of skid or slip, thus leaving the first as the sole control of the turn. Only confusion can result from instruction leading to continued and arbitrary alternation of the functions of these two controls.

There are two reasons why it is preferable, since a choice must be made, of assigning control of skid or slip to the rudder and control of turn to the ailerons. First, it is desirable that the turn be the best possible if the pilot fails to follow through with the secondary control—about which more will be said later. This objective dictates use of the ailerons for turn control. Flight tests of three popular light airplanes disclosed that the skids resulting from turns made with rudder only were consistently in the order of six to seven times greater than the slips due to using ailerons only.

Second, instruction in the use of the rudder to turn leads directly to attempts to use the rudder to raise or lower the nose in steeply banked turns with the objective of turning up or down. This is directly responsible for misuse of the elevators and indirectly responsible for a large percentage of fatal accidents. Instruction that the rudder is not to be used to turn to the right or left when right or left means up or down is not a satisfactory answer to this objection to teaching rudder as the turn control. It has proved to be both ineffectual and confusing, as our accident records have amply shown.

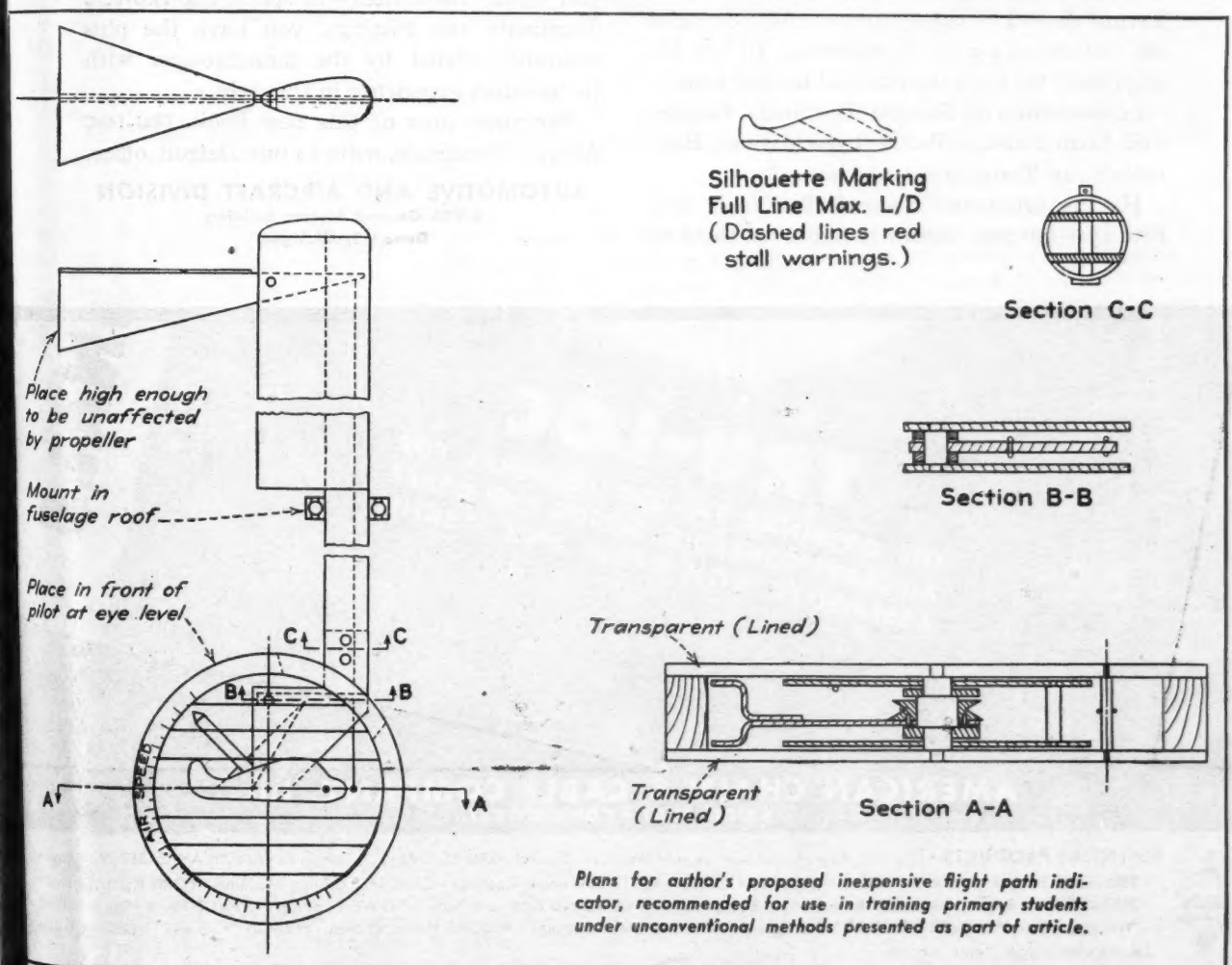
If steering is assigned to the ailerons there should be little instruction required in their use. Almost everyone has steered automobiles. If the aileron control is of the wheel type its use would be almost identical to use of the automobile steering wheel; if stick controlled a simple explanation that the stick functions like the top of the automobile steering wheel should suffice.

The difference between airplane steering and automobile steering is that the airplane control is returned to neutral after the turn has been initiated, whereas the automobile wheel is not, is not likely to present any great problem. It is not believed that an automobile driver would require more than a few blocks to accustom himself to an automobile steering mechanism modified to function as does the airplane steering mechanism.

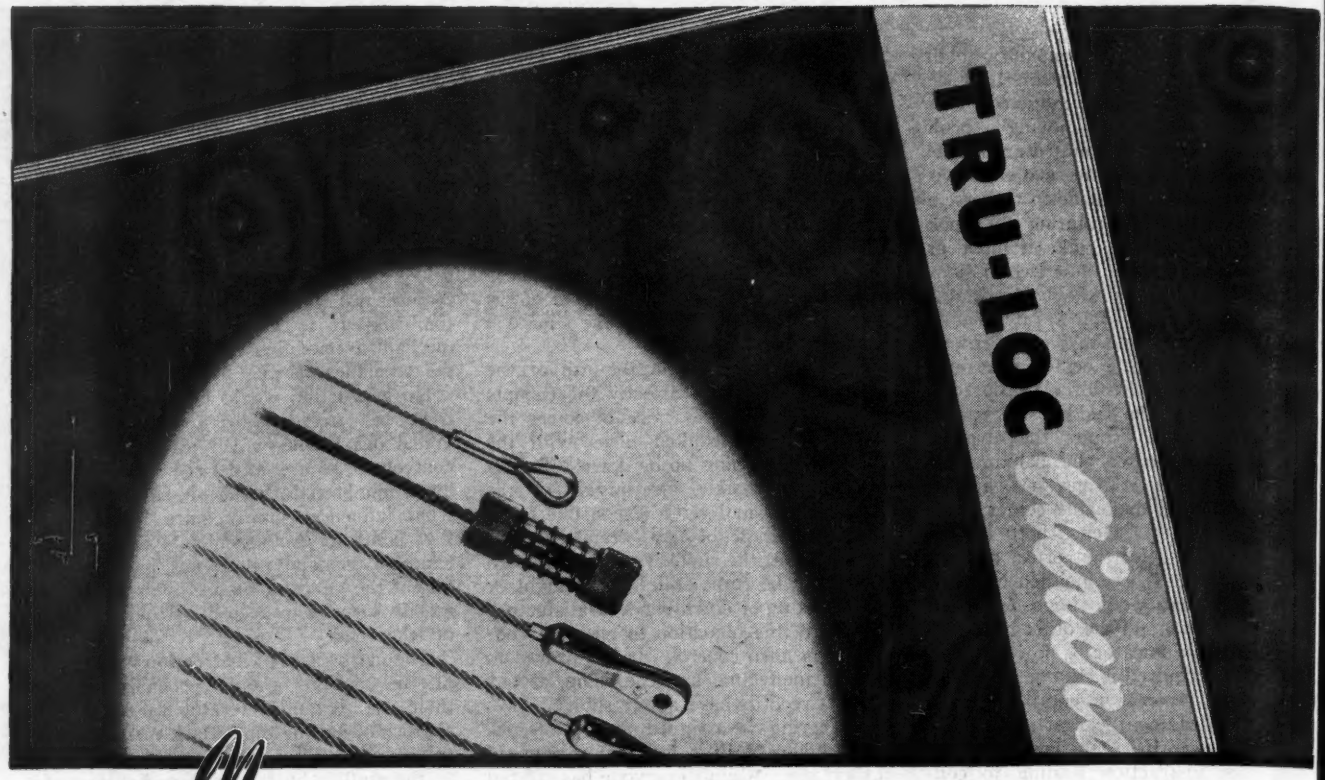
No instruction would be required relative to over-banking characteristics. When one knows which way to move a control to secure a desired result it is quite immaterial that he be informed of what influences may require his use of that control. An automobile driver, for example, certainly does not have to be taught the effect of road crowns on automobile steering to keep him from running off the road.

The major part of instruction in the use of the ailerons should probably be in their use to guide elevator use. In the absence of an angle of attack meter about the only means of detecting the approach to the stall is by trying the effectiveness of the ailerons. It is the author's suggestion that their effectiveness in causing roll should be the criterion rather than the

(*Turn to page* 237)



Plans for author's proposed inexpensive flight path indicator, recommended for use in training primary students under unconventional methods presented as part of article.



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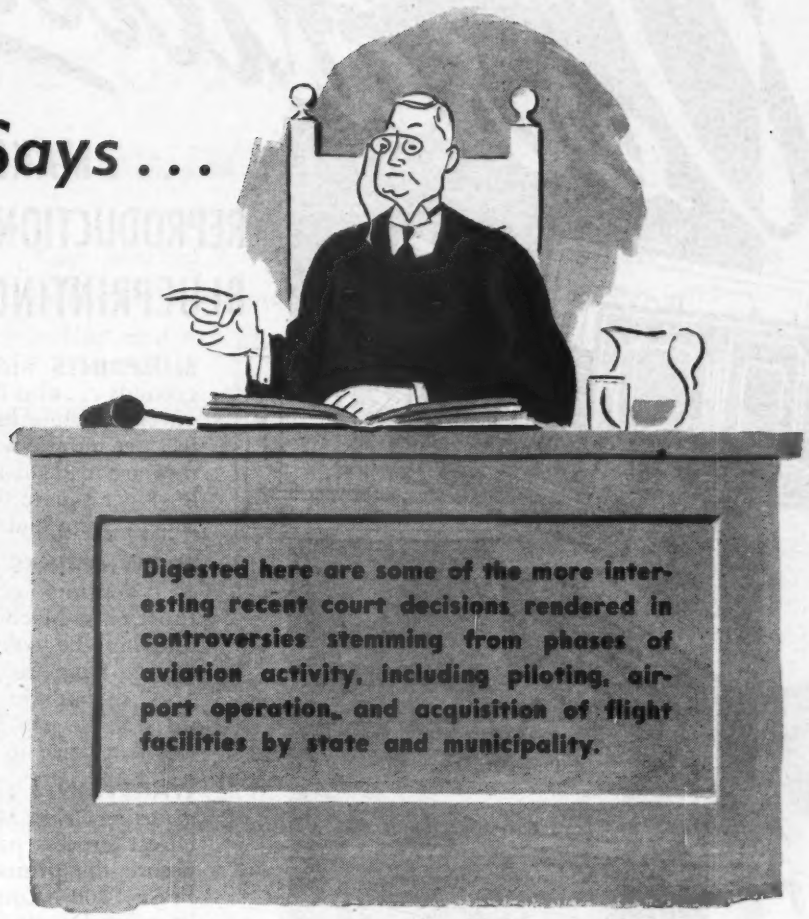

Digested here are some of the more interesting recent court decisions rendered in controversies stemming from phases of aviation activity, including piloting, airport operation, and acquisition of flight facilities by state and municipality.

By **LEO T. PARKER,** *Attorney at Law*

IT IS KNOWN that insurance contracts are strictly construed against the insurance company. This doctrine is applicable to insurance policies written for members of the military service, or those who contemplate entering such service.

For illustration, in *Bull* v. *Sun Life Assurance Co.,* it was shown that Richard Bull, a naval aviation cadet in training, made application to the defendant for a policy of life insurance. The company knew of Bull's cadet status and of his intent to continue in aviation after his period of training, and it required him to sign an endorsement containing an aviation provision, as follows:

"Death as a result, directly or indirectly, of service, travel, or flight in any species of aircraft, as a passenger or otherwise, is a risk not assumed under this policy . . . "

Later, Bull, then a lieutenant in the USNR, and alternate pilot of a plane, was killed by an explosion after a forced landing in combat. His widow sued to recover the insurance, and although the company argued that the restrictive clause relieved it from making payment, the higher court held the widow was entitled to payment, saying:

"Looking at the contract to determine whether service, travel, or flight in the aircraft resulted in the insured's death, we must conclude that it did not."

The court also held that where a life policy, issued to an aviation cadet at a time when the United States is making preparations to expand its national defense program, or is engaged in war, does not contain a war clause, it is valid although it contains an aviation clause. In this respect the court said:

"He was a naval aviation cadet when he applied for the policy and when it was issued. The defendant (company) knew that he intended to continue in such service. With such knowledge, the defendant drew the policy and determined the risk it would assume. The aviation clause we have set forth was inserted in the policy. No war clause was inserted."

Airport Outside State

It has been established that a municipality may own property for an airport where the property lies beyond the municipality's corporate limits, and it may exercise the usual powers incident to ownership.

In *McLaughlin* v. *City of Chattanooga,* suit was filed to determine the power of the city to expend public funds in the purchase of lands, for municipal airport purposes, located outside of the corporate limits, lying partly in Tennessee and extending over into Georgia. In view of the fact that a state law authorized municipalities to acquire land for airport purposes either within or without the corporate limits of said city, the higher court upheld the validity of the city ordinance appropriating $200,000 for this purpose from public funds, and said:

"The phrase 'within and without the geographical limits of such municipalities' is as broad as the universe, since every point is either within or without the limits of a municipality."

It is important to note that the court explained that when a city acquires land for a municipal airport located outside of the corporate limits and lying partly in an adjoining state, the city is not acting in its governmental, but in its corporate or proprietary capacity, and it cannot exercise the power of eminent domain, or police power, or be exempt from taxation or entitled to preferential treatment in regard to taxes.

When Airport Is a Necessity

According to past decisions, a municipal airport is considered a necessity, although a city is already provided with every means required for public convenience and transportation of commerce, and there are no public airplanes operating in and out of the city.

In *City of Reidsville* v. *Slade,* it was shown that a city council voted to condemn private lands to construct an airport. Citizens filed suit and requested an injunction against condemning the lands, because the airport was not a necessity since there were no public planes operating in and out of the city. The ordinance under which the council acted was held valid.

Value of Condemned Land

Considerable controversy has existed over the reasonable value of a portion of a tract of land appropriated or condemned for airport purposes. Courts hold that owners of land, part of which is taken for public improvement, are entitled to full

(*Turn to page* 278)

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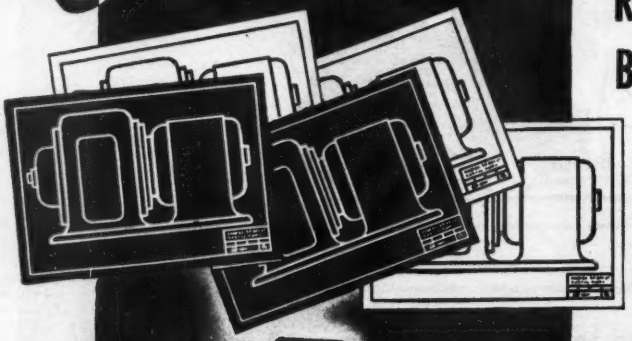

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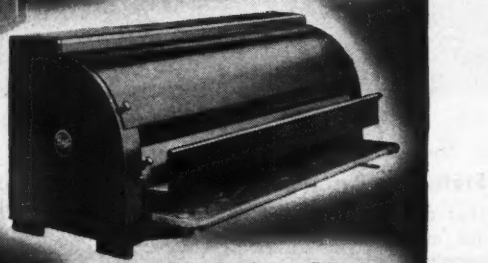

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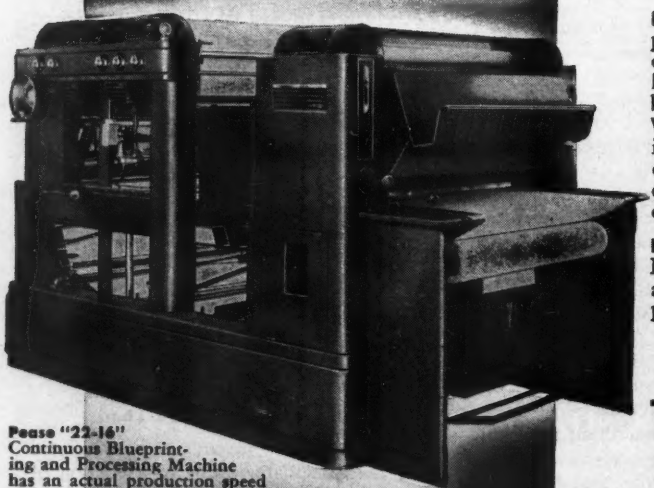

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Getting the "Gravel Grinder's" Viewpoint

New Marine Air Corps training program puts pilots in ground soldier's place for concentrated training in coordination and art of survival.

MARINE CORPS PILOTS going into action against the Japs today have two distinct advantages their predecessors didn't have. First, they know—from actual experience—the need for split-second timing in their coordination with ground troops; and, second, if ever forced down they have practical training in the art of survival in jungle territory.

They acquire these advantages when, fresh from flight or operational training schools, they reach the Marine Corps' largest Air Station at Cherry Point, N. C. Immediately upon their arrival at this base—where they'll be welded into fighting squadrons and groups—they are assigned to what is known as "Boy's Town," the full military title for which is the Ground Defense Training Unit, a tent and temporary-structure camp well isolated from the main base.

Here, under tutelage of battle-wise veteran officers, they live the life of the "gravel grinder"—the ground fighter who must still take and hold the territory over which they will fly and prepare for conquest. And, despite the fact that they have successfully completed the rigorous Navy flight training program with its stiff physical development requirements, they find that the life is "just a touch rugged."

A typical day's program, for instance, is this: 5:45, reveille; 6:00, mile run; 6:15, muster; 6:30, chow; 7:00 and 7:15, sick and police calls; 8:00, close order drill; 9:00 physical drill; 9:30, bayonet fighting; 10:30 knife fighting; 11:30, anti-judo demonstration; 12:00, chow; 1:00, field sanitation; 2:00, club fighting; 3:00, demolition demonstration; 6:00, chow; 7:30, training film; 8:50, muster; 9:00, taps.

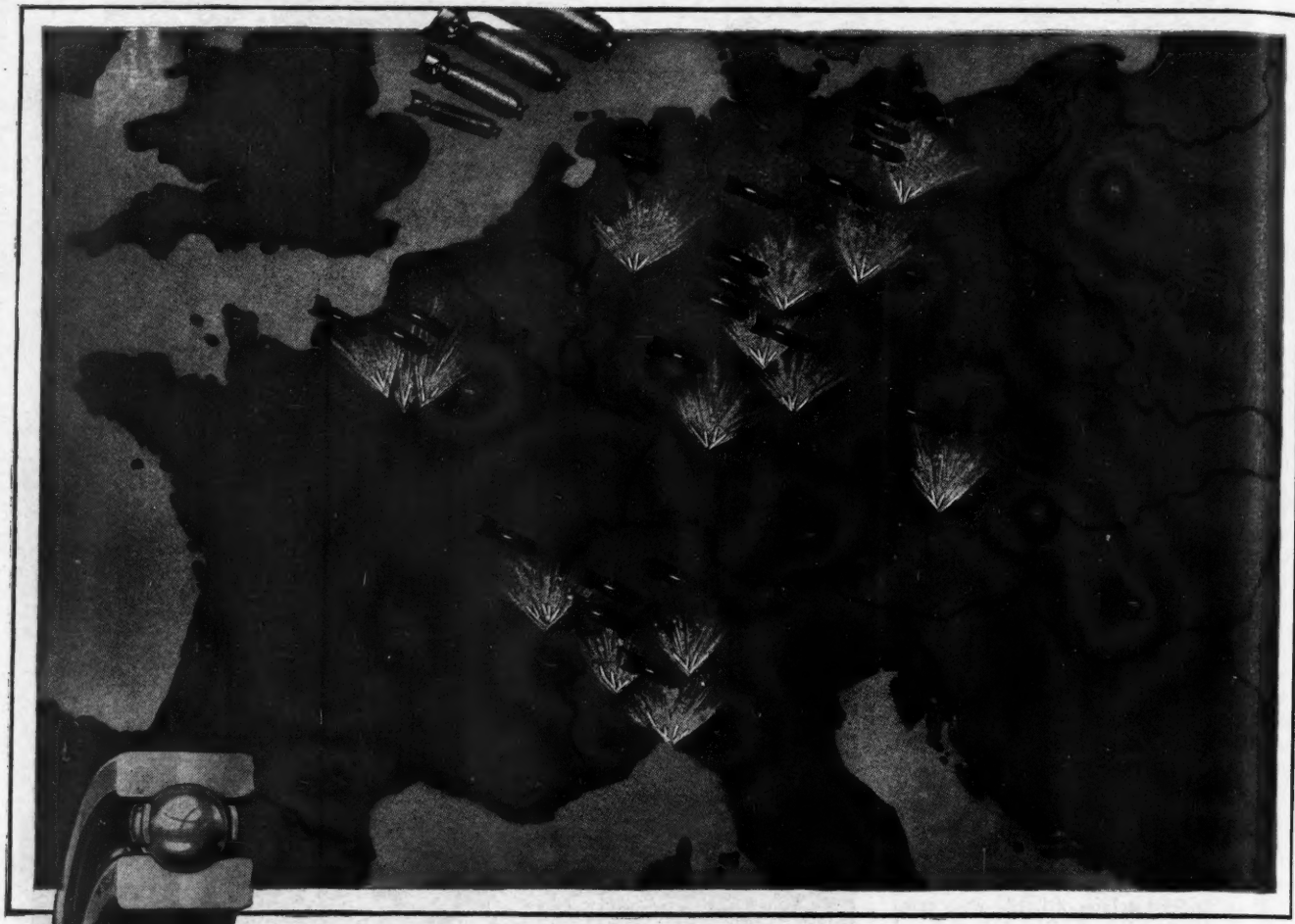
"Final examinations" of the two-weeks course bring practice landings, with most of the 100-odd pilots disembarking from landing barges to wade through bomb-charged water to hit a beach, also well loaded with charges that do more than make a lot of noise. Here they study under combat conditions the role they will play later—for Douglas SBD's flown by graduates of this same course, lay smoke screens and simulate dive bombings, and Vought F4U's simulate ground strafing runs. They learn, as they could no other way, what the ground soldier goes through in a beachhead attack—and why they as pilots must be where they're supposed to at any given second.

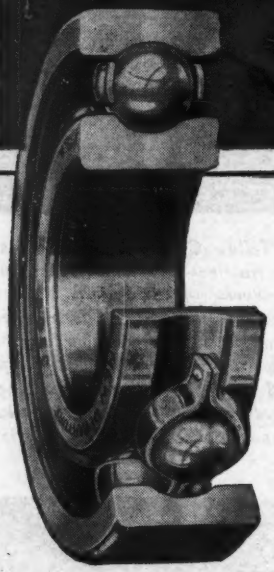
The training program is headed by Lt. Col. E. B. Diboll, one-time commander of Henderson Field on Guadalcanal, and the staff includes Lts. M. R. London, C. F. McKenna, J. T. Randazzo and Chief Warrant Officer B. F. Rippy, all South Pacific veterans.

Though these men have the curriculum well shaken down (they've graduated more than 1,300 pilots) they still keep a suggestion box in which the young flyers may say exactly what they want about the course.

The normal reaction is that given to AVIATION's correspondent: "This place is tough, but the course ought to be longer; it'll help us immeasurably when we get into action."

Marine Corps pilots learn by practice how their earth-bound fellow Corpsmen attack, take, and secure enemy-held territory. As part of their advanced training at Marine Corps Air Station at Cherry Point, N. C., these flyers take intensive two-weeks ground defense training course designed to teach them not only need for split-second timing and coordination between air and ground forces, but how to fend for themselves in case of forced landing behind enemy lines. Above: First wave of pilots, having unloaded from landing craft which has disappeared into aircraft-laid smokescreen, hit the beach with fixed bayonets in practice landing. Below: Second wave of attackers emerge from smokescreen to work their way into thick undergrowth in pursuit of classmates simulating defending enemy. (Official U. S. Marine Corps photos.)





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SHAPE OF THINGS TO COME

By GEORGE H. MILES, *Designer for Miles Aircraft Ltd., England*

The designer of newest British tandem-wing craft presents arguments for radical design, claiming alterations in basic layout overcome limitations on speed range and center of gravity movement.

IT WOULD SEEM that the airplane, as we know it today, is approaching the limit of possible development. If much further progress is to be made it may be necessary to consider radical alterations in the basic layout. Among the more serious limitations to which the orthodox airplane has always been prone are those of a very limited range of speed and small permissible movement of the center of gravity, and, as the airplane has developed, the latter has become increasingly critical.

As top speed has steadily been increased, so the stalling speed has correspondingly soared, until today we are having to tolerate landing speeds which a few years ago would have been rightly condemned as dangerous. With the advent of higher wing loadings and aspect ratios the mean chord has steadily decreased and the consequent limitation of CG range has become a serious problem.

A big advance toward overcoming the speed-range limitation was the advent of the clean cantilever monoplane combined with highlift flaps.

Rotating wing aircraft, both the free and powered types, provide another and more specialized solution to the problem of obtaining a large speed-range, but at a heavy cost in top speed and economy. Such aircraft seem likely to have a great future in certain specialized directions, as communication craft between the city center and the airfield.

The problems of CG range limitations and stowage tend to become even more serious, with the advent of buried engine installations, jet engines and large passenger carrying craft. Aircraft designers on both sides of the Atlantic are fully aware of the gravity of these problems and in both Britain and the USA, research is now being devoted to investigation of unorthodox layouts.

The two layouts which appear to have received the greatest consideration are: The tail-less type, pioneered by Dunne around 1912, and later brought to an advanced stage by Professor Hill; and the tail-first, or Canard type, of which the Focke-Wulf Ente of fifteen years ago is perhaps the best known example. The tail-first layout, however, is only a partial solution to the problem in that the position of the CG is likely to be just as critical as in the orthodox aircraft while, in addition, its view and directional stability are likely to be inferior.

The tail-less layout now being experimented with has tremendous possibilities if certain basic shortcomings can be overcome. However, care must be taken not to accept the advantages claimed by its protagonists without a thorough appreciation of its corresponding limitations. Not least among the failings of the tail-less aircraft, and one to which no satisfactory solution has yet been found, is the low value of max. C_L attainable—partly because of the large shift of the center of pressure caused by those devices which have been employed to give the high lift coefficient necessary to the attainment of a large range of speed and partly because of the aerodynamic washout needed to achieve longitudinal stability.

It would seem, therefore, that if the permissible range of CG movement is extended with no diminution in the max. C_L already attainable in the orthodox aeroplane, some layout must be found other than either the tail-first or tail-less arrangements, as neither seem to provide the solution and both introduce disadvantages peculiar to themselves.

Two further layouts seem worthy of consideration, namely the swept-forward tail-less type, as exemplified by the "Cornelius"; and the tandem wing type, which has been pioneered in France by Peyret, Delanne, and others.

It is difficult to see why the swept-forward tail-less aircraft should eliminate

(Turn to page 246)

Flight view (top) of tandem-wing "Libellula", designed by George H. Miles, shows large rear wing with aileron control and small front plane with elevators. Note vertical stabilizer in addition to the rudder controls at the mainplane tips. Parked view (above) shows retractable tricycle landing gear. Advantages claimed for the type include wider center of gravity range and "a considerable reduction in length and structure weight."

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A pilot-operated piston is used in the Vickers Aircraft Relief Valve instead of the customary spring-loaded direct-acting mechanism. The result is smoother operation and geater accuracy throughout a wider range of pressure adjustment. Variation in pressure from cracking point of valve to its maximum capacity is negligible (see curves below).

Vickers Balanced Piston Relief Valves (Model AA-11200 Series) are available in four sizes having rated capacities of 1.2, 3.5, 6.0 and 16 gpm, conforming to AN specifications. Actual capacities are, however, far in excess of these rated minimums. Without parts change all valves have operating pressure ranges from 300 to 2100 psi; adjustment is easy and simple. They comply with Winterization requirements of the Army Air Forces; their dimensions comply with the AN-6200 envelope.

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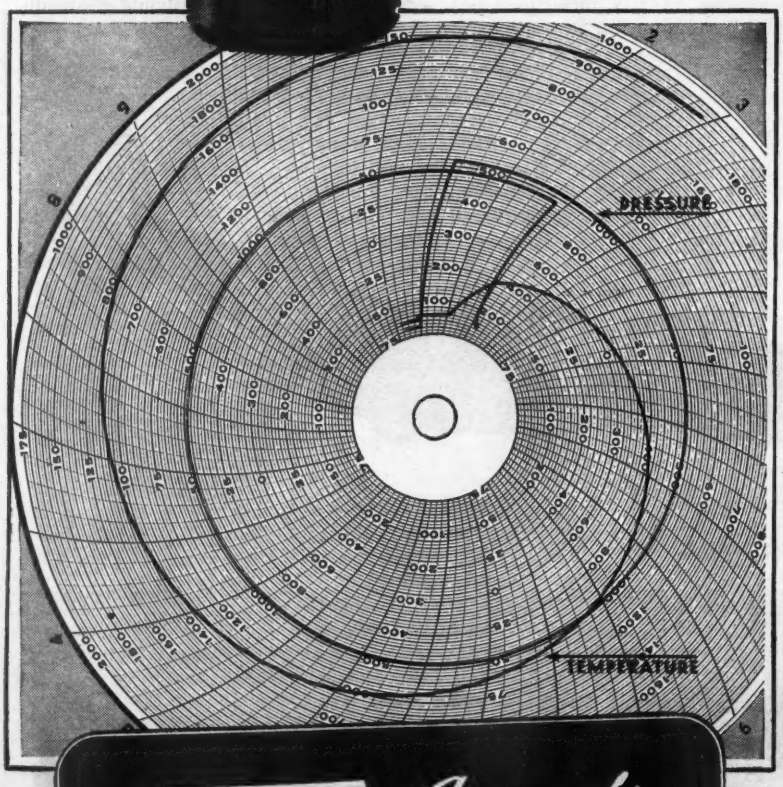
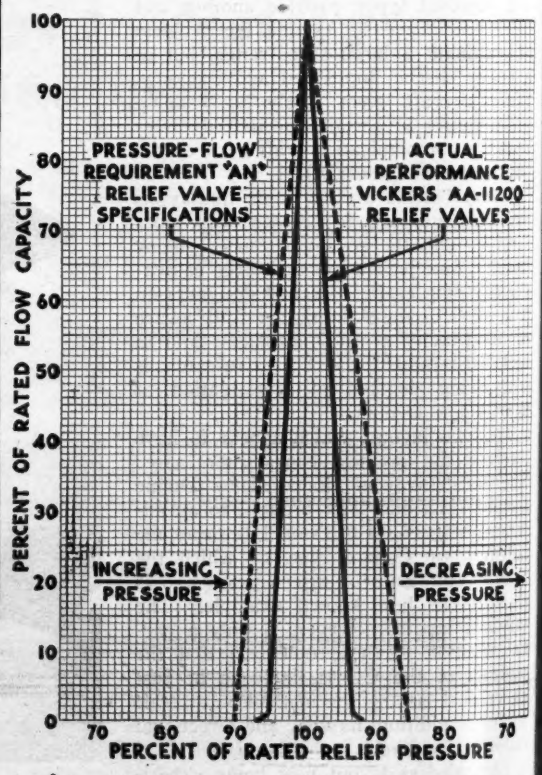


Representative of the exhaustive and severe tests to which these valves have been subjected is the Cold and Increasing Temperature Test recorded on the chart. The temperature increased from —65° F to 160° F in 26 minutes (one revolution of chart = 24 min.)



As indicated by the curves above, the variation in pressure from cracking point to maximum rated capacity of the Vickers Balanced Piston Relief Valve is considerably less than permissible under AN Standards. Consequently, less pressure differential is required between relief valve setting and unloading valve pressure.

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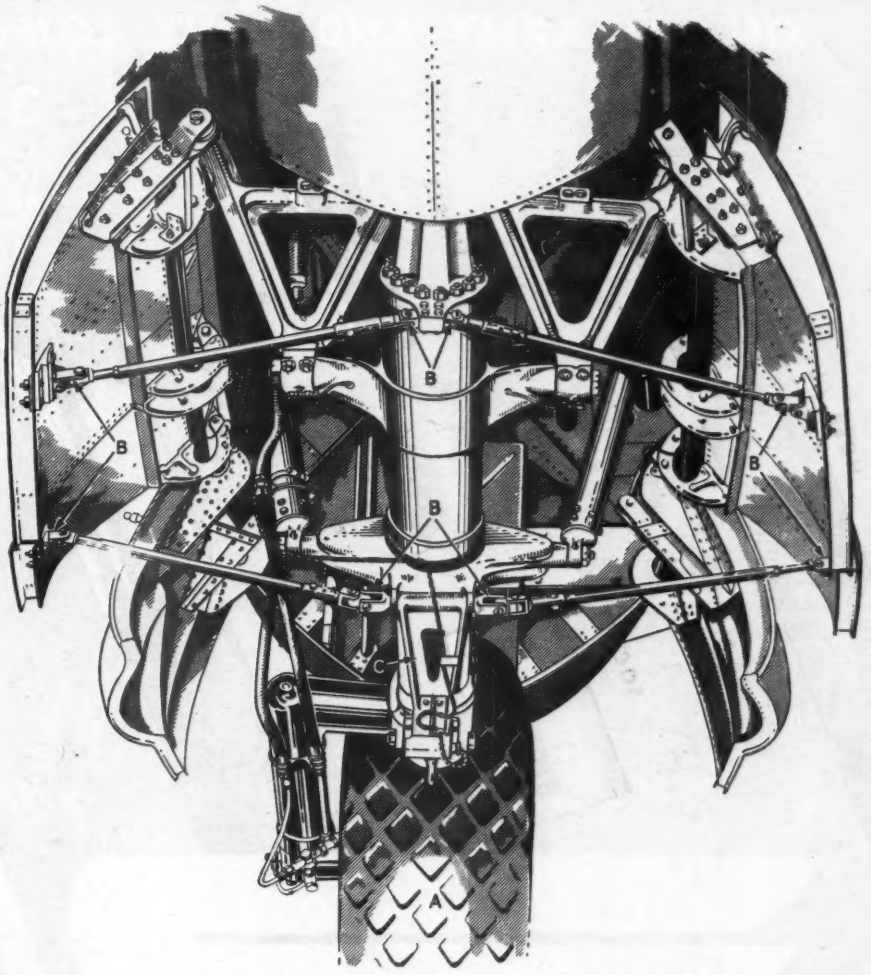
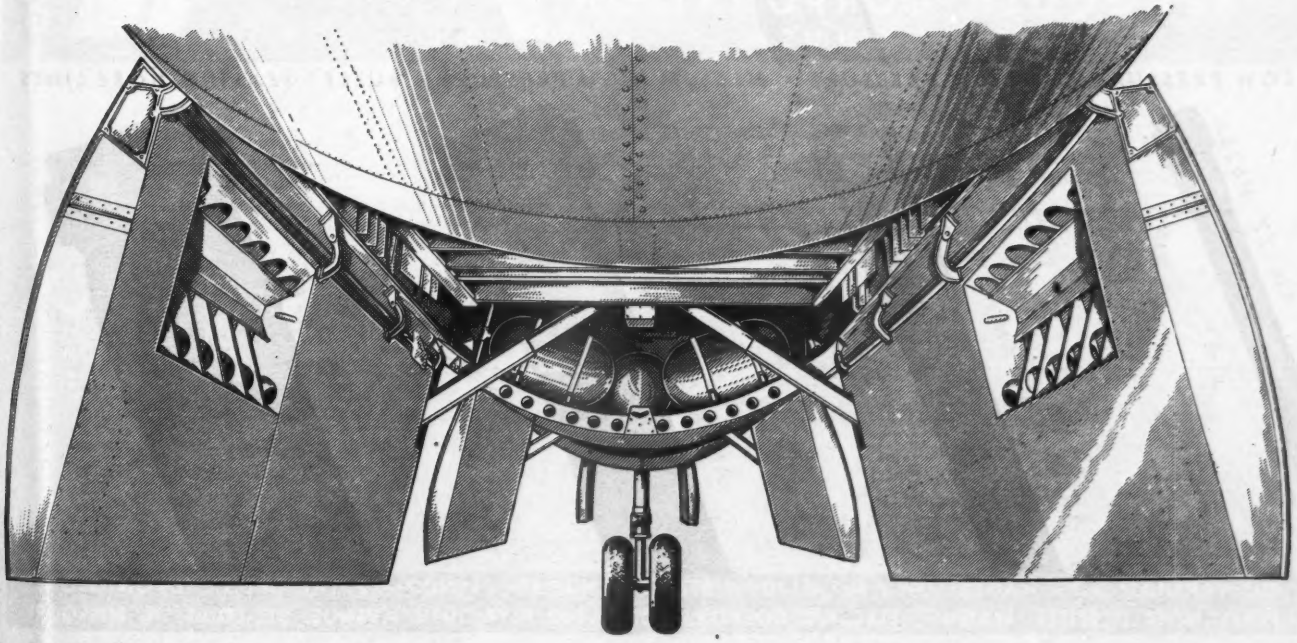
RELIEF VALVE

Aft section of Martin B-26 "Marauder" main landing gear fairing—seen here from rear—is pulled into place as wheel A is moved up and forward to its position behind engine by four rods with universal joints, seen at B, the two lower rods being connected to oleo shock strut just above torque scissors C and two top rods at top of shock strut. Note that fairing is built-up double skin structure designed to withstand hard field use.



Looking forward toward double nose wheel of Boeing B-29 "Superfortress", showing doors for double bomb bays. Opened and closed electrically, bomb bay doors are of built up construction with both inner and outer skins, and are attached to fuselage by four hinge arms.



'THE STANDARD HOSE FITTING'
ON ALL ARMY AND NAVY COMBAT AIRCRAFT

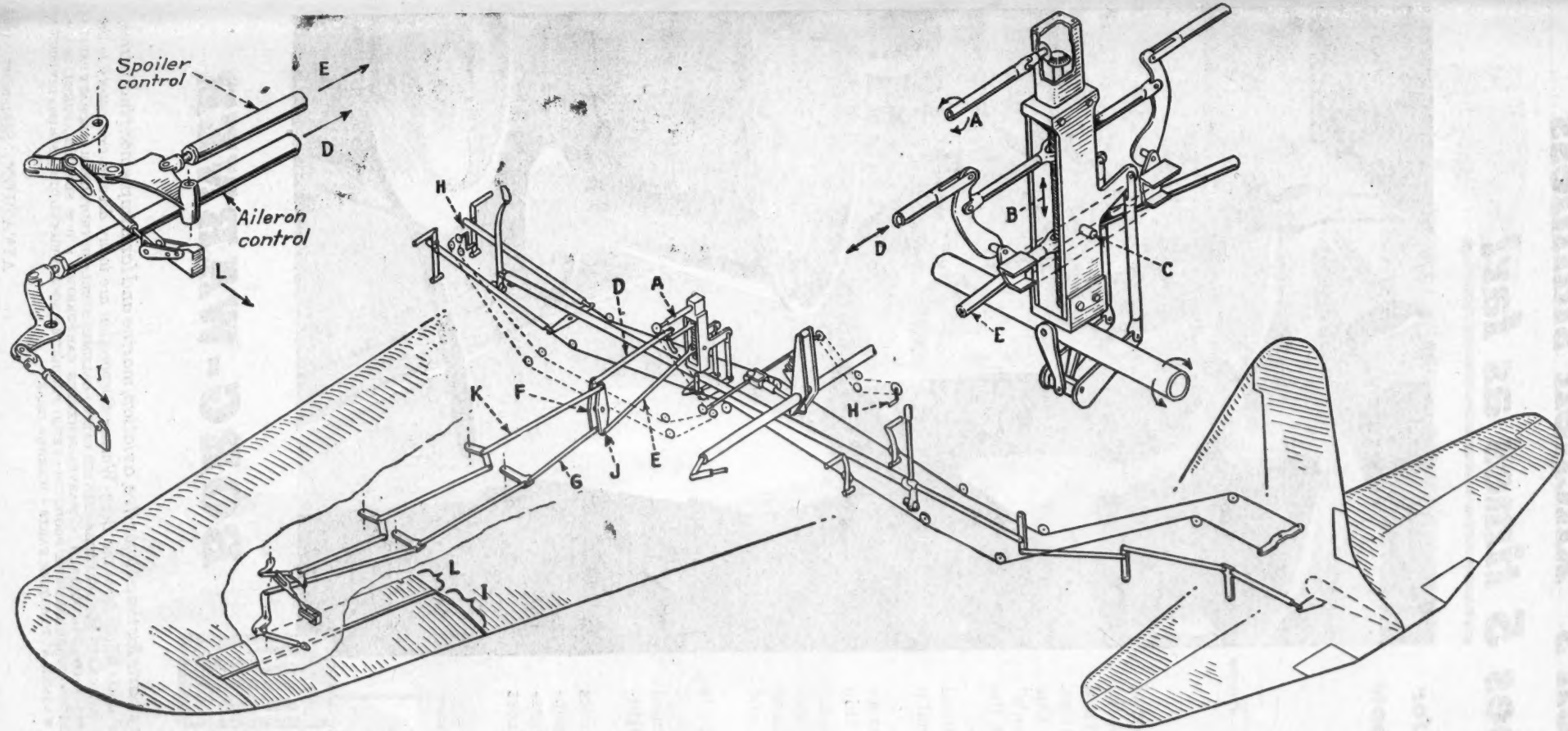
3 PIECES *(EACH REPLACEABLE)*

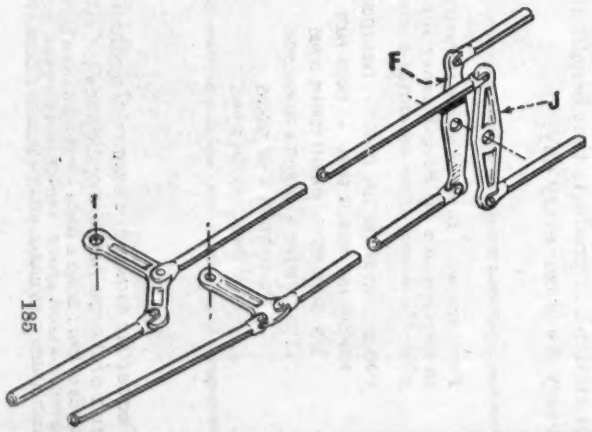
ASSEMBLY WITHOUT SPECIAL TOOLS. NO TIGHTENING OR ADJUSTMENT AFTER ASSEMBLY. FITTINGS CAN BE REMOVED FROM HOSE AND RE-USED OVER 100 TIMES.

AEROQUIP CORPORATION
JACKSON, MICHIGAN, U. S. A.

LOW PRESSURE • MEDIUM PRESSURE • MEDIUM HIGH PRESSURE • BULLET SEALING HOSE LINES

303 WAREHAM BLDG., HAGERSTOWN, MD.—1709 W. 8TH, LOS ANGELES—PRENCO—72 STAFFORD ST., TORONTO, ONT.
PERMANENT LICENSEE: WAGNER ELECTRIC CORPORATION, 6400 PLYMOUTH AVENUE, ST. LOUIS 14, MISSOURI

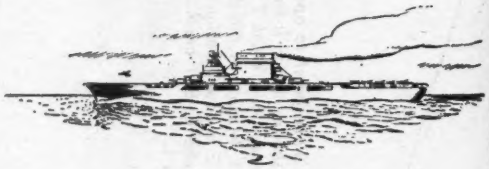


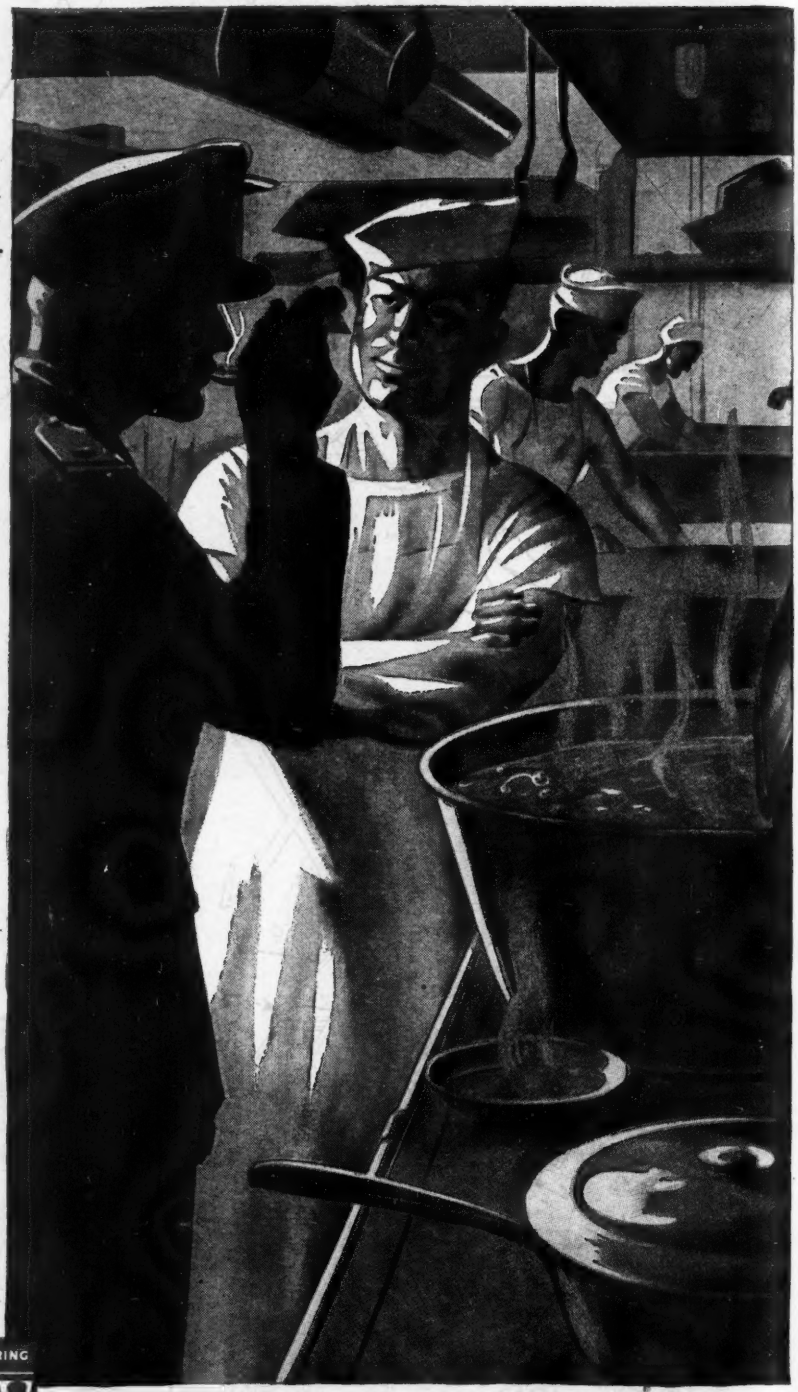


Phantom view shows details of operation of Vought OS2U "Kingfisher" spoiler system. Change from aileron to spoiler is made through handcrank H which operates tube A (also shown in detail at upper right). This turns screwjack B, which moves aileron control D down from operative position to hinge point C, at same time moving spoiler control E down from hinge point to operating position. When B is set as shown, motion is transmitted via push-pull tube D, through bell crank F and linkage system G to aileron I. When B is turned so that D is at center C and E is down, motion is transmitted through push-pull tube E, bell crank J, and linkage system K to spoiler L.

In the "Queen's" kitchen stainless steel now goes 5 times as far!

Another triumph for America's know-how with metals . . .





Everywhere in the galley of that queen of the seas—the aircraft carrier—there's the gleam of stainless "clad" . . . on tables and lockers . . . around ranges and refrigerators.

What a time and work saver it is. One wipe and it's clean. Truly, the "Queen's" kitchen is demonstrating a trend that the nation will follow when the war is over.

Stainless steel is a costly and critical alloy—so American ingenuity has found a way to make it go five times as far!

The Ingersoll Division of Borg-Warner has perfected a means of wedding a thin surface of stainless steel to a much less expensive low-carbon steel base. This economical new "IngAclad" is being produced for the galleys of our aircraft carriers and for many other wartime needs.

"IngAclad" is one of a hundred products that pour from the mills and factories of Borg-Warner into the hands of our armed forces. And all give evidence that our fighters are getting the finest.

For years Borg-Warner's many units have made a vast variety of essential equipment for the farm and home and for transportation . . . products that benefit almost every American every day.

Partners with the Aviation industry in peace and war, Borg-Warner supplies these and other essential parts.

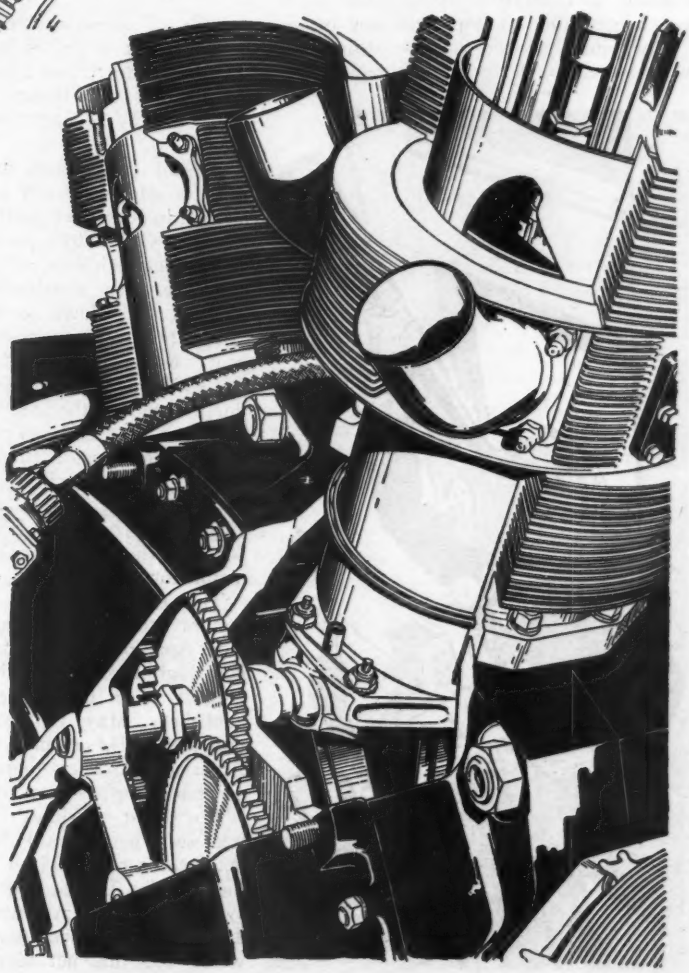
HYDRAULIC, VACUUM AND FUEL PUMPS • CARBURETORS
REDUCTION AND PROPELLER GEARS • ENGINE PARTS
UNIVERSAL JOINTS • AIRCRAFT CONTROL CHAINS
AIRCRAFT CLUTCHES • HELICOPTER TRANSMISSIONS
POWER TURRETS • OIL COOLERS
COIL SPRINGS AND FLAT SPRINGS

ENGINEERING B-W PRODUCTION

BORG-WARNER

Peacetime makers of essential operating parts for the automotive, aviation, marine and farm implement industries, and of Norge home appliances . . . these units which form the Borg-Warner Corporation are today devoted exclusively to the needs of war: BORG & BECK • BORG-WARNER INTERNATIONAL • BORG-WARNER SERVICE PARTS • CALUMET STEEL • DETROIT GEAR AIRCRAFT PARTS • DETROIT VAPOR STOVE • INGERSOLL STEEL & DISC • LONG • MARBON • MARVEL-SCHEBLER CARBURETER • B-W SUPERCHARGERS, INC. • MECHANICS UNIVERSAL JOINT • MORSE CHAIN • NORGE • NORGE MACHINE PRODUCTS • PESCO PRODUCTS • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR

Cut-away views of Bristol "Hercules" 14-cyl. twin-row 1,600-hp. sleeve valve aircooled engine showing, at left, front view from right side and, below, left-front view. Cylinders have three intake ports at rear and two exhaust ports in front. Sleeves, which are steel cylinders have four ports, one of which alternately opens one each of intake and exhaust ports in cylinders. Sleeves have combined reciprocating-rotating motion, imparted by gear trains (partially shown in both sketches) operating from crankshaft through crank to which is attached ball assembly (seen at base of cylinder in sketch at right).



Clue to the Course Of Air Carrier Stocks

By **RAYMOND L. HOADLEY,** *Financial Editor, "Aviation"*

A review of recent action of the carrier securities indicates their possible course in the near future and during the war-to-peace transition period.

WHILE FUTURE GROWTH PROSPECTS continue to be the major factor in the market price of airline stocks, traders in these issues are now placing more stress on their current earning ability than at any time in the past.

Airline stocks slumped badly in the March quarter. Reflecting this sharp decline, they lagged noticeably in the vigorous upswing in the stock market last spring.

But late in July the air carrier stocks began to give a much better account of themselves and the reason was not hard to find: The industry's earnings had resumed their wartime climb.

Wall Street, and perhaps some trade officials, too, had assumed last year that there just was no ceiling—except excess profits taxes—to the wartime gains of this growing industry. But the March quarter slump in profits didn't make good reading, and industry officials decided it was a good time to stop, look, and listen.

They quickly found that operating costs were increasing faster than revenues. A stretch of unseasonable flying weather brought this situation into sharp relief. As a result there was a widespread paring of expenses that brought immediate results—and Wall Street began to breathe easier.

One of the largest domestic airlines, for example, instituted a 10 percent reduction in personnel, pretty much all down the line. Others took similar steps. Costs of American Airlines, which had hit a high of 97.8c. per plane-mile in the first quarter, were down to 85c a plane-mile in April. Operating costs of Transcontinental & Western Air dropped to 91c. a plane-mile in the June period from something over $1 in the first three months and 99c. in the second quarter of last year. Pres. Jack Frye attributed the cost decline to improved efficiency, better operating conditions, and a larger number of airplanes. The return of additional transports by the Army was, of course, a big factor for all the lines.

The combination of these favorable factors brought such improved earnings, from April on, that the airline stocks made new high records for the year early in August, when the financial reports were published. May, for example, had been the first 1944 month when profits of American Airlines topped those of the corresponding 1943 month.

Northwest Airlines' passenger revenues set a new monthly high in June, and net income rose for the line as was also the case for United and Eastern. Pennsylvania-Central Airlines, which had a deficit in the March quarter, more than wiped out this net loss in May alone, while Braniff is reported in that month to have earned double the average rate for the first four months of the year. TWA came out of the red in April, enabling it to show net income for the first six months of $568,576 against $732,578 in the like 1943 period. Chicago & Southern had net of $34,900 in May against a deficit of $12,600 in the like 1943 period.

What, then, is the immediate earnings outlook for the airlines? Now that costs are in somewhat better alignment and the Army is steadily though slowly returning planes to the industry, it appears likely that profits may continue close to their wartime peaks until sometime after the European war is mopped up.

And now that the stock market is following airline earnings more closely, the current earning power should add strength to the market position of air stocks. It is too much to expect, however, that airline equities will move up or even remain stabilized if the rest of the market is reactionary because of political, reconversion, or military factors.

It is fortunate indeed that the airlines have had a big wartime volume of traffic and a vast amount of transport work to do for the government; for they have to meet many extra expenses—such as postwar planning—that would stand out like a sore thumb on the basis of prewar traffic.

Every time an airline takes a proposal to the Civil Aeronautics Board for new routes, many thousands of dollars have been spent in market and traffic research and study. The cost of gathering all the

(*Turn to page* 275)

...THE FUTURE IS OFTEN AS CLEAR AS A SUMMER NIGHT

The Lockheed Constellation

Facts show the Constellation to be a superior airplane. Its importance, however, derives not from at-the-moment achievement or triumph, but rather from its significant place in the history of flight, in the long history of human relations. Scientific development moves slowly. Yet there are rare moments when the ingenuity of the drafting boards and the skills of the benches combine perfectly, swiftly accelerating the steady pace of progress. And at these moments, the future becomes as clear and star-filled as a summer night; a future that in this instance pledges ever greater planes to come, ever wider horizons, and a true bond of understanding among the peoples of the earth.

The Lockheed Constellation

Highest speed of any transport

Longest range of any transport

Largest load-carrying capacity of any transport

Greatest rate of climb of any transport

And these performance factors make the Constellation the SAFEST of any transport.

ANOTHER EXAMPLE OF LOCKHEED LEADERSHIP

QUESTIONS

Q. I understand that the Constellation can fly on any two of its four engines. Is this true? –E. E. M., St. Louis

A. *True. It is unique in that it can CLIMB on two engines.*

Q. Does it fly too high for comfort? –F. S., Pasadena

A. *Actually it flies high FOR comfort. The Constellation operates over weather, yet cabin pressures are kept at levels no higher than many mountain resorts.*

Q. A friend of mine insists that the Constellation needs *two* airports to land it. What about it? –H. J. K., New York

A. *Landing speed is less than 80 m.p.h. About ½ airport.*

Q. How many people will the plane carry? –W. H. McM., Boise

A. *As a sky-liner–64 passengers; sky-sleeper–34 passengers at night, 48 in daytime. Crew of 6.*

Q. I'd like to ride in a Constellation. –Joan H., Brooklyn

A. *The Army Air Forces are taking all we make. After the war, you'll get your wish.*

Send in your questions. Address: Lockheed Aircraft Corporation, Department 69-55, Burbank, California

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FOR DEPENDABILITY IN FLIGHT

LOOK TO *Lockheed* FOR LEADERSHIP

SHEET NUMBER D-24
CLASSIFICATION . . . . . Materials
SUBCLASSIFICATION . . . . . Aluminum Alloys

Aluminum Alloy Sheet and Strip Sheet Commercial Specifications

Alloy and Temper.	Thickness In.	Tensile Strength Lb./Sq.In. Min.	Yield Strength Lb./Sq.In. Min.	Elongation In 2 Inches Percent Min.	Bend Test Factor N
24S-O	.012-.032	35,000	.....	12	0
	.033-.063	35,000	.....	12	1
	.064-.128	35,000	.....	12	2
	.129-.249	35,000	.....	12	4
	.250-.500	35,000	.....	12	6
24S-T	.012-.020	64,000	42,000	10	4
	.021-.040	64,000	42,000	13	4
	.041-.051	64,000	42,000	13	5
	.052-.128	64,000	42,000	15	6
	.129-.249	64,000	42,000	14	8
	.250-.500	62,000	40,000	12	10
24S-O Pureclad	.012-.032	33,000	.....	8	0
	.033-.063	33,000	.....	10	1
	.064-.500	34,000	.....	12	2
24S-T Pureclad	.012-.020	59,000	39,000	10	4
	.021-.040	59,000	39,000	12	4
	.041-.063	59,000	39,000	13	5
	.064-.128	62,000	40,000	13	5
	.129-.249	62,000	40,000	11	8
	.250-.500	62,000	40,000	11	10
53S-O	.013-.032	19,000	.....	20	0
	.033-.064	19,000	.....	22	0
	.065-.128	19,000	.....	22	1
	.129-.258	19,000	.....	25	2
	.259-.500	19,000	.....	25	3
53S-W	.013-.032	28,000	16,000	12	2
	.033-.050	28,000	16,000	15	3
	.051-.258	28,000	16,000	20	3
	.259-.500	28,000	16,000	18	4
53S-T	.013-.031	35,000	28,000	8	3
	.032-.036	35,000	28,000	10	4
	.037-.064	35,000	28,000	10	5
	.065-.258	35,000	28,000	10	6
	.259-.500	35,000	28,000	10	7
61S-O	.010-.020	22,000	.....	14	0
	.021-.128	22,000	.....	16	1
	.129-.249	22,000	.....	18	2
	.250-.500	22,000	.....	18	3
61S-W	.013-.020	30,000	16,000	14	2
	.021-.250	30,000	16,000	16	3
61S-T	.013-.020	42,000	35,000	8	2
	.021-.036	42,000	35,000	10	3
	.037-.064	42,000	35,000	10	4
	.065-.128	42,000	35,000	10	5
	.129-.258	42,000	35,000	10	6
R301-O	.....	27,000	12,000	18	..
R301-W	.....	57,000	37,000	16	..
R301-T	.....	65,000	57,000	8	..

(Courtesy Reynolds Metals Co.)

American's Complete Broaching Service

Solving Production Problems of War

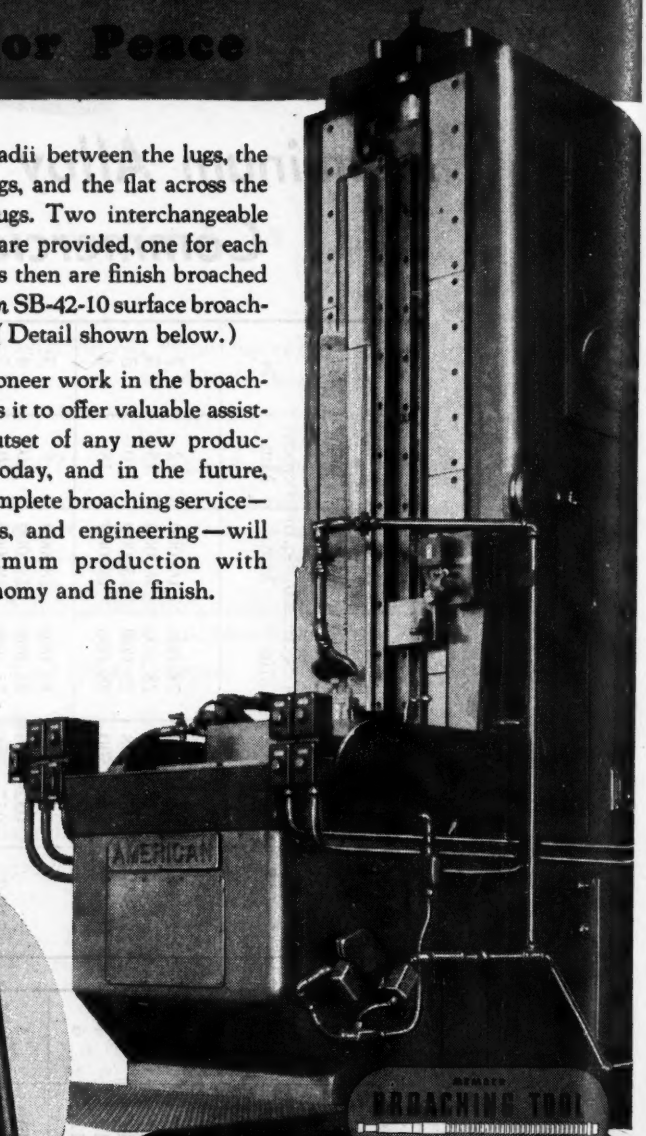
. . . Ready to Plan for Peace

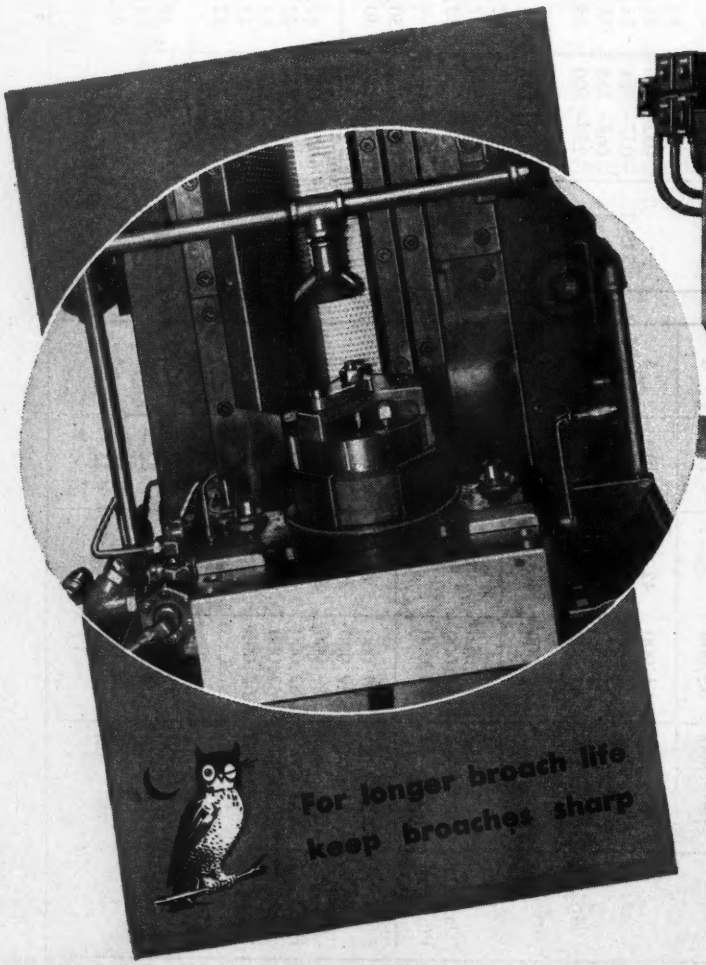
The advantages of broaching by *American* are well known to the Nation's leading manufacturers. Almost every war industry has made use of broaching, the *American* way, to secure fast, accurate, economical output.

For example, American Broach and Machine Company engineers recently designed the broach tooling and setup for the production of a new aircraft part. One operation entails the finishing of the external contour of a two-part stop sleeve.

An *American* SB-66-15 surface broaching machine (shown at the right) rough broaches the radii between the lugs, the sides of the lugs, and the flat across the index of the lugs. Two interchangeable tooling setups are provided, one for each part. The parts then are finish broached on an *American* SB-42-10 surface broaching machine. (Detail shown below.)

American's pioneer work in the broaching field equips it to offer valuable assistance at the outset of any new production effort. Today, and in the future, *American's* complete broaching service—machines, tools, and engineering—will provide maximum production with maximum economy and fine finish.





American

BROACH AND MACHINE CO.

ANN ARBOR, MICHIGAN

BROACHING MACHINES
PRESSES
BROACHING TOOLS
SPECIAL MACHINERY

DIVISION OF SUNDSTRAND MACHINE TOOL CO. ROCKFORD, ILLINOIS U.S.A.

Aluminum Alloy Sheet and Strip Sheet Commercial Specifications

Chemical Composition
Wrought Aluminum Alloys

Alloy	Si		Fe		Fe plus Si	Cu		Mn		Mg		Cr		Ni		Zn	Pb		Bi		Ti	Others		Aluminum
	min.	max.	min.	max.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	max.	min.	max.	min.	max.	max.	Each max.	Total max.	
P. C. Liner							0.05		*		*		*		*	*		*		*	*	0.05	0.15	99.40–99.85
Foil							0.05		0.04		*		*		*	*		*		*	*	0.05	0.15	99.40 min.
2S		0.20	At least .50 and 3 x Si		0.85	0.10	0.20		0.05		*		*		*	0.07		*		*	*	0.05	0.15	99.00–99.30
3S	At least .15 less than Fe			0.50		0.10	0.20	1.00	1.30		*		*		*	0.07		*		*	*	0.05	0.15	97.00 min.
11S	0.20	0.40		0.50		5.00	6.00		*		*		*		*	0.15	0.40	0.60	0.40	0.60	*	0.05	0.20	Remainder
14S	0.75	1.00		0.60		4.10	4.70	0.60	0.90	0.30	0.60		0.07		*	0.07		*		*	*	0.05	0.15	Remainder
17S	0.45	0.70		0.60		3.60	4.40	0.50	0.80	0.50	0.75		0.10		*	0.07		*		*	*	0.05	0.15	92.00 min.
A17S	0.45	0.70		0.70		2.30	2.70		0.10	0.25	0.45		0.10		*	0.07		*		*	*	0.05	0.15	95.00 min.
18S	0.40	0.80		0.50		3.70	4.40		0.10	0.45	0.75		0.07	1.80	2.20	0.07		*		*	*	0.05	0.15	Remainder
Mod.18S	0.40	0.80		0.50		3.70	4.40		0.10	0.45	0.75		0.07	1.80	2.20	0.07	0.20	0.60	0.20	0.60	*	0.05	0.15	"
24S		** 0.45		0.50		4.20	4.90	0.50	0.80	1.40	1.80		0.10		*	0.07		*		*	*	0.05	0.15	"
25S	0.75	1.00		0.70		4.30	5.00	0.60	0.90		0.03		0.07		*	0.07		*		*	*	0.05	0.15	"
32S	11.50	12.50		0.60		0.70	1.10		0.10	1.00	1.30		.07	0.70	1.10	0.07		*		*	*	0.05	0.15	"
A51S	0.80	1.20		0.80			0.30		0.10	0.50	0.75	0.20	0.30		*	0.07		*		*	*	0.05	0.15	"
52S					0.40		0.10		0.10	2.30	2.70	0.20	0.30		*	0.07		*		*	*	0.05	0.15	"
53S	45% of Mg	65% of Mg		0.30			0.10		*	1.10	1.40	0.20	0.30		*	0.07		*		*	*	0.05	0.15	"
61S	0.50	0.70		0.50		0.25	0.40		0.10	0.85	1.10	0.20	0.30		*	0.07		*		*	0.15	0.05	0.15	" "

* May be present up to limits under "others" but not added intentionally.

Government Specifications

Alloy	Federal Spec.	Navy Spec.	Army-Navy Aero Specifications	Aeronautical Material Specifications (Ams)		
2S	QQ-A-561	47-A-2 INT	.....	4001(O)	4003(1/2H)	
3S	QQ-A-359	47-A-4 INT	.....	4006(O)	4008(1/2H)	
24S	QQ-A-355	47-A-10	AN-A-12	4035(O)	4037(T)	
24S Pureclad	QQ-A-362	Federal	AN-A-13	4040(O)	4041(T)	4042(RT)
52S	QQ-A-318	47-A-11	.....	4015(O)	4016(1/4H)	4017(1/2H)
53S	QQ-A-334	47-A-12 INT	.....	.....		
61S	QQ-A-327	47-A-12 INT	.....	4025(O)	4026(W)	4027(T)
R-301	Formal specifications not yet issued.					

(Courtesy Reynolds Metals Co.)

THUNDER OUT OF RUSSIA!

You now see the Red Star of Russia on hundreds of American-built Thunderbolts fighting on the Eastern front. At the controls are daring Russian pilots daily pouring destruction upon Hitler's dwindling hordes.

For the Russians have found that the withering fire from the Thunderbolt's eight 50-caliber machine guns makes it a worthy companion of their own famous Stormovik for ripping tanks, locomotives, fuel dumps and other enemy targets on the ground.

The air forces of England, France and Brazil have also adopted the Thunderbolt as a weapon to suit the demands of many tactical situations—from high altitude fighting to low level strafing and dive bombing. And thus it is that Thunderbolt squadrons are converging upon enemy strongholds from every United Nations front, helping draw ever tighter the noose of ultimate defeat.

The production *in quantity* of this lethal, seven-ton fighting plane continues. The courage and skill of the United Nations pilots who fly it are known and feared in Tokyo as in Berlin. And with these pilots into every battle go the hearts of the thousands here at Republic who are pledged to keep the Thunderbolts rolling until there's nothing left to shoot at—high or low!

WRITE THAT BOY TODAY . . V-MAIL

Republic Aviation Corporation, Farmingdale, Long Island, New York, and Evansville, Indiana.

Republic *firsts* in war point to *firsts* in peace

REPUBLIC AVIATION
CORPORATION
Specialists in High-speed, High-altitude Aircraft

Review of Patents

By A. HARRY CROWELL, *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

Aircraft Engine Drive Mechanism is designed for engine embodying number of banks of cylinders having reciprocable pistons for driving two parallel crankshafts which drive a centrally disposed propeller shaft. Drive mechanism, interposed between crankshafts and propeller shaft, consists of shock-absorbing reduction gear with flexible coupling means to damp out torsional vibrations.—2,350,377, filed July 3, 1940, patented June 6, 1944, J. Tjaarda, assignor to Briggs Mfg. Co.

Landing Field Locator System provides for beacons placed beyond opposite ends of runway, which project oscillating beams through arcs from vertical to lateral, to enable incoming pilot to determine exact location of field when it is obscured by atmospheric conditions close to ground.—2,350,407, filed Sept. 5, 1941, patented June 6, 1944, T. E. McDowell, assignor to The Pyle-National Co.

Avigating Device consists of compass-graduated base, dial to indicate wind direction, ground segment to indicate direction of destination from departure point, and air segment for reading speed. Device is intended to solve problems involved in avigating aircraft in straight line in given direction, and to provide solutions for ready consultation so that, with change in speed or direction of wind, avigator can make correction in setting of device.—2,350,424, filed July 24, 1941, patented June 6, 1944, W. W. Smith.

New Parachute Design features variable vent which is restricted during initial stages of fall to give quick opening of canopy. As canopy opens farther, vent area is increased, thus gradually slowing descent and prolonging and reducing shock loading, after which vent area is decreased for slow safe landing.—2,350,646, filed Sept. 25, 1941, patented June 6, 1944, F. Smith, assignor to Pioneer Parachute Co.

Airfield Traffic Control invention is concerned with electrically operated marking system to indicate to pilot, while he is still at a considerable distance from field, preferred runway, alternate runways, velocity of wind at field, and consequent severity of drift with which he will have to contend. Device, which includes wind vane and anemometer, is automatically controlled by direction and velocity of wind, or it may be manually set to correspond with given conditions.—2,350,594, filed Aug. 12, 1941, patented June 6, 1944, W. K. Dallas.

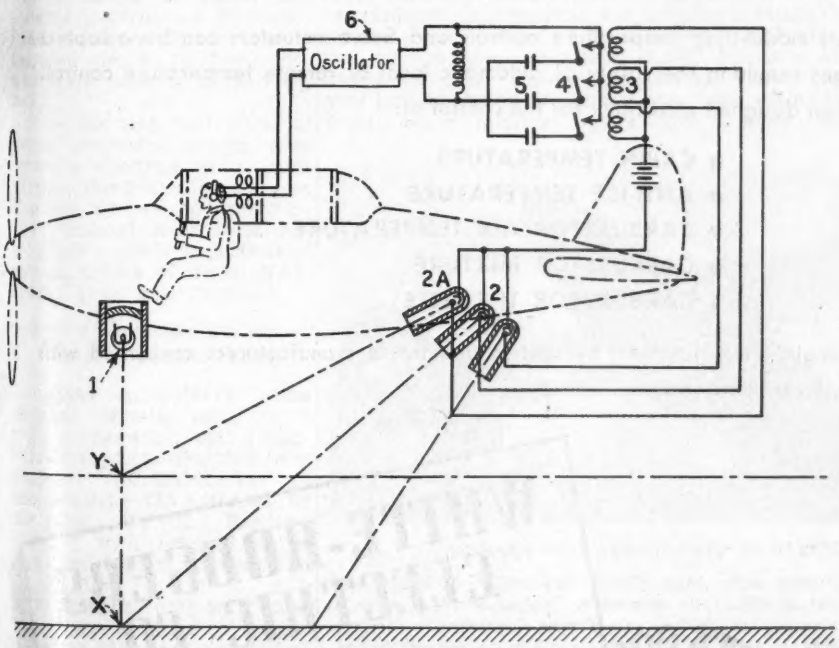
Parachute Design is intended to prevent oscillation and entanglement of shroud lines. Chute has flat top from which depend elongated fins arranged in crossed relation to cause descent in approximately vertical line.—2,350,480, filed Jan. 12, 1942, patented June 6, 1944, P. J. Swofford, assignor to T. B. Fite (1/16) and J. F. Hopson (1/16).

Aerial System invention for radio beacons provides for two aerials set very close together, to permit radiation in preferential direction and in given range of frequencies, with no special additional aerial required for circular radiating beam. Additional advantage reported for system is mounting on plate of small dimensions.—2,350,747, filed May 9, 1942, patented June 6, 1944, P. P. Gamet; vested in Alien Property Custodian.

Wing Flap Device is stated to automatically effect control and actuation when aircraft reaches predetermined speed, also to adjust flaps into normal flight position from takeoff position. Motor which actuates flaps is subject to a control responsive to aircraft speed. Speed responsive device includes pitot or venturi tube, or centrifugal governor.—2,350,751, filed Oct. 5, 1940, patented June 6, 1944, C. Gliubich; vested in Alien Property Custodian.

Wing With Variable Surface comprises movable leading and trailing portions fitted on fixed central wing body, which includes gears, threaded shaft, and racks to accomplish actuation.—2,350,809, filed Sept. 27, 1940, patented June 6, 1944, G. Pelessoni; vested in Alien Property Custodian.

Pressure Regulator Design for airplane cabins claims simple means of automatically bridging various conditions of operation, through which mechanical difficulty is avoided and no supervision required. Pump supplying air to cabin is driven by engine of plane, and as engine will generally run at constant speed, constant volume of air will be induced—2,350,896, filed June 25, 1940, patented June 6, 1944, H. Jde; vested in Alien Property Custodian.



Altitude determining system for training pilots in landing of aircraft, provides audible signal of distances such as 5, 10, and 15 ft. above field so pilot can correlate visual and aural observations, thus increasing ability to land safely. One embodiment of invention is shown in accompanying illustration. Reflector of light source (1) projects beam to earth at (X), beam being picked up by photoelectric cell (2), thus energizing relay (3), closing contact (4), and connecting condenser (5) in oscillator frequency determining circuit, whereupon oscillator (6) supplies definite frequency to earphones to indicate corresponding altitude to pilot. If beam strikes earth at (Y), cell (2A) will be energized and impress different frequency on earphones, to indicate this height. More than the three cells shown may be employed.—2,350,820, filed Aug. 10, 1942, patented June 6, 1944, M. Rettinger, assignor to Radio Corp. of America.

Book Reviews

DOWN TO EARTH, by David Greenhood, with illustrations by Ralph Graeter. Holiday House, New York City, 246 pages, illustrations, appendix, index. $4.

This is offered as a book for the amateur, designed to give him an understanding and appreciation of maps, whether his interest be as user, maker, or collector. Interspersed with anecdotes and biographies, Mr. Greenhood's volume carefully covers the field of mapping. Of special interest to flyers are those chapters on projections and great circle charts and on isogram maps.

AIR NAVIGATION MADE EASY, by James F. Naldich. McGraw-Hill Book Co., New York. 115 pages, illustrations, problems, index. $1.

This book on avigation emphasizes the fundamentals for students and private pilots. In non-technical language, principles of contact flying and dead reckoning are covered, and there are sections on map reading and use of the compass. The volume aims to be of aid to the student, through teaching simple drift, radius of action, and alternate-airport problems.

TRANSPORT AIRCRAFT OF THE WORLD, by Lester Ott. Franklin Watts, N. Y. 110 pages, index. $2.50.

Volume describes and illustrates passenger and cargo aircraft of United States, England, Canada, The Soviet Union, Germany, Italy, and France. Included are photographs, sketches, and break-down drawings designed to acquaint engineers or laymen with the actualities of present models and the potentialities of future aircraft which are now in the development stage.

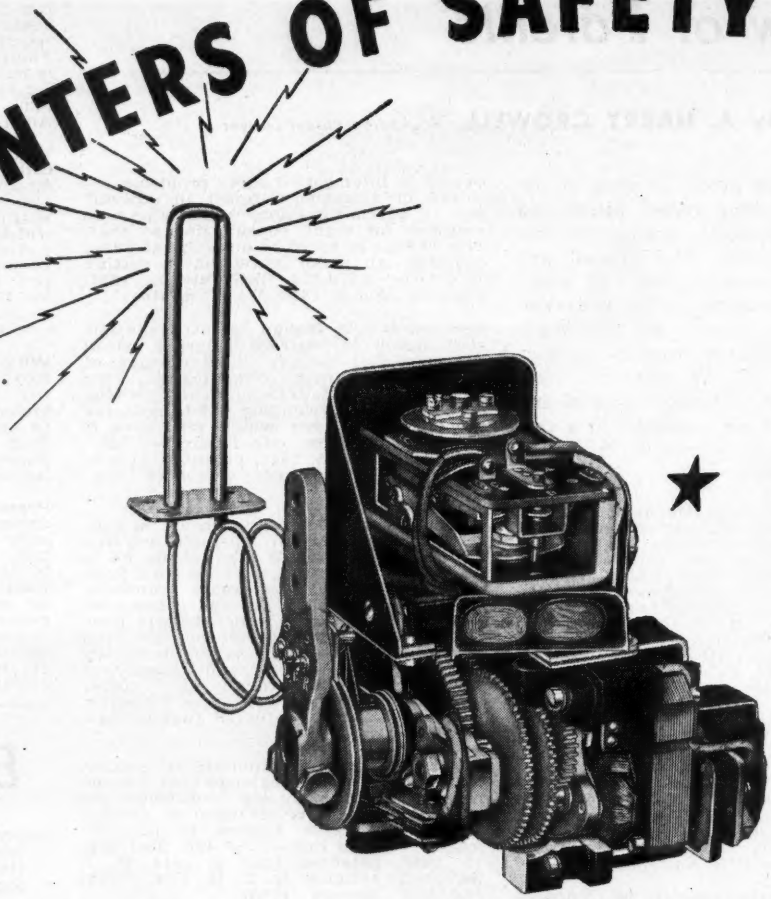
BASIC STRUCTURES, by F. R. Shanley. John Wiley & Sons, N. Y. 356 pages, appendix, index. $4.50.

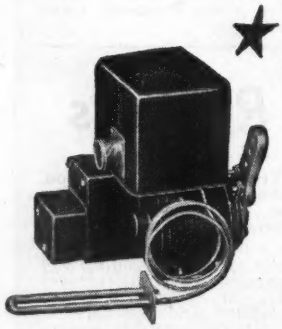
A text on the basic principles of force transmission for all types of structures, with special applications to aeronautics. Much of the subject matter is not new, but the author's arrangement of material and the methods of development are unconventional. He starts with known forces and develops, step by step, methods of transmitting these forces through space. This constitutes a new treatment of mechanics textbook subjects.

From this point on, arrangement has been dictated by actual development and analysis of the structure as a means of force transmission, but information on mechanical properties of materials is pre-

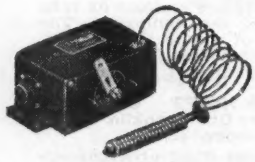
(Continued on page 282)

NERVE CENTERS OF SAFETY

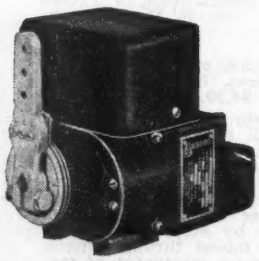




Compact temperature controlled actuator especially adapted for anti-ice applications. Arm rotation adjustable within range of 30 to 120 degrees. Torque output up to 75 inch-pounds.



Modulating temperature control used for regulating carburetor air temperature.



Servos available in several types for applications involving additional power requirements.

WHITE-RODGERS AUTOMATIC CONTROLS FOR AIRCRAFT FLIGHT OPERATIONS

White-Rodgers modulating temperature controls and Servo actuators can be adapted to most designs requiring the safety of automatic local or remote temperature control. They have been designed especially for the control of:

- **CABIN TEMPERATURE**
- **ANTI-ICE TEMPERATURE**
- **CARBURETOR AIR TEMPERATURE**
- **CARBURETOR MIXTURE**
- **CARBURETOR THROTTLE**

On request, engineering data will be sent to authorized manufacturers concerned with the above or similar applications.

LET'S GO! KEEP 'EM FLYING!

WHITE-RODGERS ELECTRIC CO.
SAINT LOUIS

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

Airport Program Making Promising Strides; New SWPA Division Tackles Plane Disposal

. . . Prompt sale of light war planes recommended . . . Landmark "air addresses" favored over grid idea . . . Base operators seek "go-ahead" signal . . . Safety Bureau reports 1943 accidents . . . CAA opens data sections . . . Future of supercharging gaged at B-W meeting.

CAA, the public, and Congress are increasingly convinced that a comprehensive airport program should be encouraged and aided financially by local and federal governments, as vital to the growth of non-scheduled flying.

Of the total 3,000 airfields proposed in CAA Administrator Charles I. Stanton's new recommendation to Congress, all but 100 are intended for personal and other non-scheduled flying. The billion dollar CAA proposal ties in with a bill recently introduced by Rep. Jennings Randolph, which would authorize the federal government to match funds with the States under a formula similar to that under which the highway system was built.

The thinking and plans of many interested groups were recently clarified in a Joint Airport Users Conference (see Transport news) sponsored by the National Aeronautic Association. Many experts read papers, copies of which NAA, Washington, will furnish.

SWPA Aviation Division Tackles Plane Disposal

Surplus Army-Navy plane disposal became more of a routine operation with establishment under Surplus War Property Administration of the Aviation Div., headed by Lt. Col. W. B. Harding, charged with over-all policy and planning for movement of the craft.

Domestic surplus craft sales have been assigned to Reconstruction Finance Corp., which has turned details over to Defense Plant Corp. Because the CAA's War Training Service had worked closely with DPC, it is being switched to the surplus program. Working under Harding are: E. L. Traylor, in charge of sales and operations; Thos A. Wadden, in charge of appraisal, location, etc.; E. E. Lothrop, in charge of component parts; and George Elsman, who acts in an advisory capacity on operations. James A. Garfield is RFC's representative in the deals.

Under present methods, DPC-owned planes bought from private owners are offered to the original owner at ceiling price. If he does not take it, the present WTS user gets an offer, also at ceiling price. If not taken then, the plane is advertised through CAA regional offices.

Report of the Surplus Aircraft Advisory Subcommittee recommends that tactical war surplus planes be cleared from the market into an "unabsorbed surplus" within four months and transport planes within nine months. Here they would be held for six months for sale to schools, memorials, etc., after which they would be scrapped. Personal aircraft and components would have to be disposed of in three years. Several manufacturers think war transport craft should be sold to foreign airline operators.

Recommends Prompt Sale Of Light War Planes

An aircraft subcommittee, headed by L. Welch Pogue, chairman of CAB, recommends in report to Surplus War Property Administrator Will L. Clayton, that surplus war planes suitable for private use be sold promptly for cash. This means light liaison planes and trainers of lower horsepowers. Army and Navy designate planes not needed, SWPA decides how many will be declared surplus and when, and then the RFC acts as selling agency.

RFC has been selling surplus civilian WTS planes for months, through CAA regional offices. Total sales are nearing 3,000. Planes of all types, and gliders, already available for sale, are estimated to total 10,000 or more. Most sales, so far, are to fixed base operators, few to individuals. RFC is planning to set up about 35 sales centers throughout the nation.

"KINGCOBRA"—WITH PLENTY OF VENOM

New Bell P-63 "Kingcobra" fighter plane, more powerful version of renowned P-39 "Airacobra", is powered with 1,500-hp. two-stage Allison as compared with single-stage engine of P-39, and higher compression is obtained through use of fuel supercharger geared at one speed for medium altitudes and at higher speed for high altitude. Horsepower increase is rated at 300 and, with four-bladed prop, puts plane in close-to-400-mph. class. P-63 is 700 lb. heavier than P-39, has laminar-flow wing with 4-ft. increase in span, bringing it to slightly over 38 ft. Service ceiling is 35,000 ft., 5,000 ft. more than P-39's. Souped-up armament includes 37-mm. cannon firing through prop hub, and four .50-cal. machine guns, two in wings and two in nose. Droppable belly and wing tank installations are added, and combat radius is 50 percent greater than P-39's. (AAF Materiel Command photo.)

Coming Up

October 5-7: Society of Automotive Engineers National Aircraft Engineering & Production Meeting, Engineering Display, Hotel Biltmore, Los Angeles.

October 5-7: National Electronics Conference, Medinah Club, Chicago.

October 20: Air Transport Meeting, Institute of Aeronautical Sciences, Hotel Statler, Washington.

November 9-10: Fall Meeting, Institute of Aeronautical Sciences, Dayton.

November 13-14: National Association of State Aviation Officials, Annual Meeting, Oklahoma City.

November 15-18: Second Annual Clinic of Domestic Aviation Planning, Oklahoma City.

December 4-6: Society of Automotive Engineers National Air Cargo Meeting, Hotel Knickerbocker, Chicago.

December 5-7: Aviation Distributors & Manufacturers Association, Second Annual Meeting, Hotel Jefferson, St. Louis.

December 17: Wright Brothers Lecture, Institute of Aeronautical Sciences, Washington.

January 8-12: Society of Automotive Engineers Annual Meeting & Engineering Display, Book-Cadillac Hotel, Detroit.

January (date to be announced): Thirteenth Annual Meeting, Institute of Aeronautical Sciences, New York.

April (date to be announced): Spring Meeting, Institute of Aeronautical Sciences, Detroit.

Landmark "Air Addresses" Favored Over Grid

Proposals that the country be marked off in grid pattern for the guidance of contact flyers were analyzed by John E. P. Morgan, director of the Personal Aircraft Council of the Aero Chamber. Many observers agreed with Morgan that the grid pattern would be impractical. But the suggestion of Morgan and the Coast & Geodetic Survey that existing longitude and latitude markings be divided into smaller coordinates and plot-

ted on a standard map, was thought feasible.

Using these coordinates, an "air address" could be plainly marked on all landmarks—like lakes, towns, river junctions, mountains—which contact flyers are accustomed to use as guides. A glance at the map would give the pinpoint location of any such landmark, and directional pointers on the ground would give the orientation.

Base Operators Seek "Go-Ahead" Signal

Operators of airports, fixed bases, and schools, especially those who have been let out of training contracts with the services, are facing difficult problems. They can get pilots, released from WTS and Air Force contract schools; they can get airplanes from military surpluses being sold; and they can get some gasoline for essential operations. But they do not feel free to go ahead and advertise for customers because of WPB and Manpower Commission restrictions.

Many of them feel that, since aviation is expected to play a big part in postwar reemployment, they should be allowed to go ahead and lay the groundwork now, rather than stand idle. Efforts are being made by private flyer groups to obtain a go-ahead order from Washington.

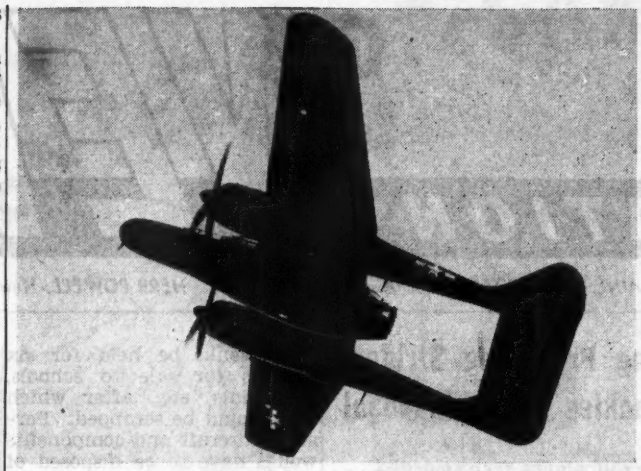
Safety Bureau Reports 1943 Accidents

Aircraft accidents, as reported to the Safety Bureau, CAB, during 1943, totaled 5,428. Of these 1,166 involved only minor or no injury to personnel and/or aircraft; 391 were "ground accidents"; and 3,871 involved injuries or death or marked damage to aircraft.

Compared with the calendar year 1942, there was a numerical increase of 547 serious accidents, a 16.5 percent "up." However, in 1943, the average number of certificated pilots and students increased from 222,280 (in '42) up to 261,514. Considering this increase, the accident trend for 1943 remained the same as in 1942.

In order of the highest frequency, forced landings, collisions with objects other than aircraft, spins or stalls, collisions with other aircraft in flight, and propeller injuries to persons on the ground show a decided increase. There was a marked downward trend in takeoff, landing, and miscellaneous accidents.

Owners are advised by CAA not to invite unqualified service pilots from the front to fly their planes. Most such pilots are not experienced with light planes, or are out of practice, and numerous serious accidents have resulted. There will be more, as additional pilots return, CAA says, unless the public cooperates with its request.



DEADLY LADY OF THE EVENING

Northrop "Black Widow" P-61 night fighter, world's largest pursuit plane. Big as medium bomber and weighing more than 25,000 lb., it has twin booms and jutting nose, as shown in flight photo (top). Twin power plants are 2,000 hp. P & W's equipped with four-blade Curtiss propellers. Extremely fast and highly maneuverable, plane can be throttled down to low speed for landing at night or in fog on small landing strips, and incorporated is full-span landing flap. Large fuel capacity gives extensive operational range. Armament consists of 20-mm. cannon and .50-cal. machine guns. Crew of two or three and ammunition boxes are variously protected from enemy machine gun fire by armor and deflector plates and bullet-proof transparent sections.

CAA Opens Data Sections

Technical information sections in each of the CAA's 79 District offices, to give pilots, airport and school operators, and all interested in aviation complete answers to many aviation questions, have been established by the Aircraft Section of the CAA General Inspection Div. Each will have a complete library of necessary information on aircraft of all types, and engines and instruments. Bulletins, usually those written by manufacturers, will be available covering maintenance, repair, and servicing of their products, and as revisions are made, the files will be altered.

Future of Supercharging Gaged at B-W Meeting

Gathered in Milwaukee, recently, as guests of Borg-Warner Corp. and its Milwaukee Div., McCulloch Engineering Corp. (now B-W Superchargers), was the industrial and business press, for a conference on possible postwar developments in internal combustion engines, with special attention to use of superchargers to increase power.

C. S. Davis, president of Borg-Warner, emphasized that interest in superchargers has been stimulated by wartime needs of greater engine performance. At present all supercharger production is allocated to military needs, but he believes that, in the postwar period, trends toward lighter engines will open a wider field for supercharging. He stressed the question of the reduction of costs and the increase of engine efficiency by supercharger use.

E. W. Wasielewski, chief engineer of B-W Superchargers, revealed his belief that engine power may be doubled. And J. P. Stewart, general manager, said postwar private aircraft will open a large field for supercharging.

★ SPOT CHECKING ★

Renville H. McMann, procurement control manager of Republic Aviation Corp., has been appointed to serve on the East Coast Aircraft War Production Council. Mr. McMann's duties will be to co-ordinate dealings in surplus materials between AAF and the manufacturers.

Summer meeting of IAS was underway at Los Angeles at press time and topics scheduled included: Loads in flight, gas flow fields, stress and vibration analyses, aerodynamic balance on control surfaces, altitude chamber tests, and use of automatic pilot.

Sen. James E. Murray of Montana, chairman of the war contracts subcommittee of the Senate Military Affairs Committee, has indicated that he will introduce a postwar aviation bill in this session of Congress. Proposed bill will incorporate measures to maintain a strong postwar air force and expand air transportation, training programs, and airport facilities.

Flights: AEA announces new record of 17 hr. 57 min from Foynes, Eire, to N. Y. . . . PAA reveals new trans-atlantic record for naval transport planes is 17 hr. 45 min. . . . First nonstop flight from London to Washington was recently made by an ATC Douglas C-54. . . . Boeing flying boat of British Overseas Airway Corp. has set new record of 11 hr. 33 min. from Foynes to Botwood.

Cooperation of the advertising agencies is sought in an educational campaign to give to wounded service men technical and business information on current engineering and commercial developments. Cleveland Chapter of National Industrial Advertising Assn., is sponsor through its committee

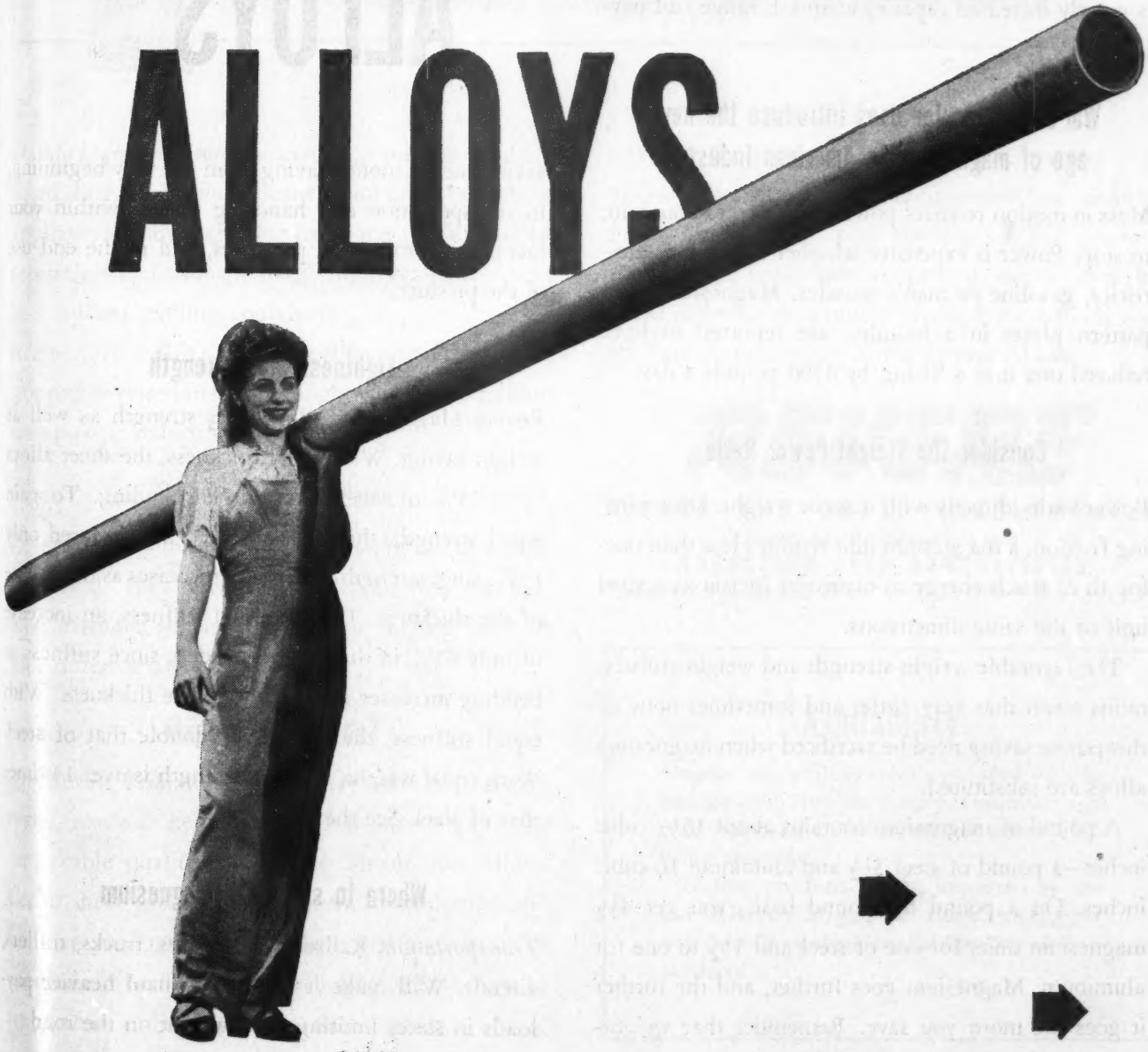
AVIATION'S Maintenance Awards Go to Airlines and Service Groups

Annual Maintenance Convention of the Air Transport Assn., held in Chicago, saw AVIATION's Annual Maintenance Awards given to all airlines and to the Army and Navy maintenance groups, signalizing their universal efficiency under trying war conditions.

Chief subjects considered at the ATA gathering were line maintenance, anti-icing and de-icing, technical developments, and cooperation between manufacturers and maintenance heads to reduce time which is required for test flights.

In attendance were 46 airline maintenance men, 45 manufacturers' representatives, CAA and NACA leaders, Army and Navy officers, and the press. Otto E. Kirschner, American Airlines' director of aircraft engineering, was elected new chairman.

REVERE MAGNESIUM ALLOYS



Lightening the burden of weight on men and machines . . .

REVERE MAGNESIUM ALLOYS

EVERY pound of Magnesium Alloy substituted for other metals will save weight. In the case of steel, the saving with equal thickness is 77% and with Aluminum Alloy it is 37%.

Magnesium wing tips, floor beams, oil and fuel tanks, seats, engine parts, wheels, housings, fairings, panels and many other parts have effected tremendous savings in the weight of modern aircraft. The result is greatly increased capacity in speed, range and payload.

War's spectacular uses introduce the new age of magnesium to American Industry

Mass in motion requires power—to start, to maintain, to stop. Power is expensive whether it is steam, electricity, gasoline or man's muscles. Magnesium alloy pattern plates in a foundry, are reported to have reduced one man's lifting by 4500 pounds a day.

Consider the Weight-Power Ratio

Power varies directly with mass or weight. Disregarding friction, a magnesium unit requires less than one-fourth as much energy to overcome inertia as a steel unit of the same dimensions.

The favorable weight-strength and weight-stiffness ratios mean that very little, and sometimes none of this power saving need be sacrificed when magnesium alloys are substituted.

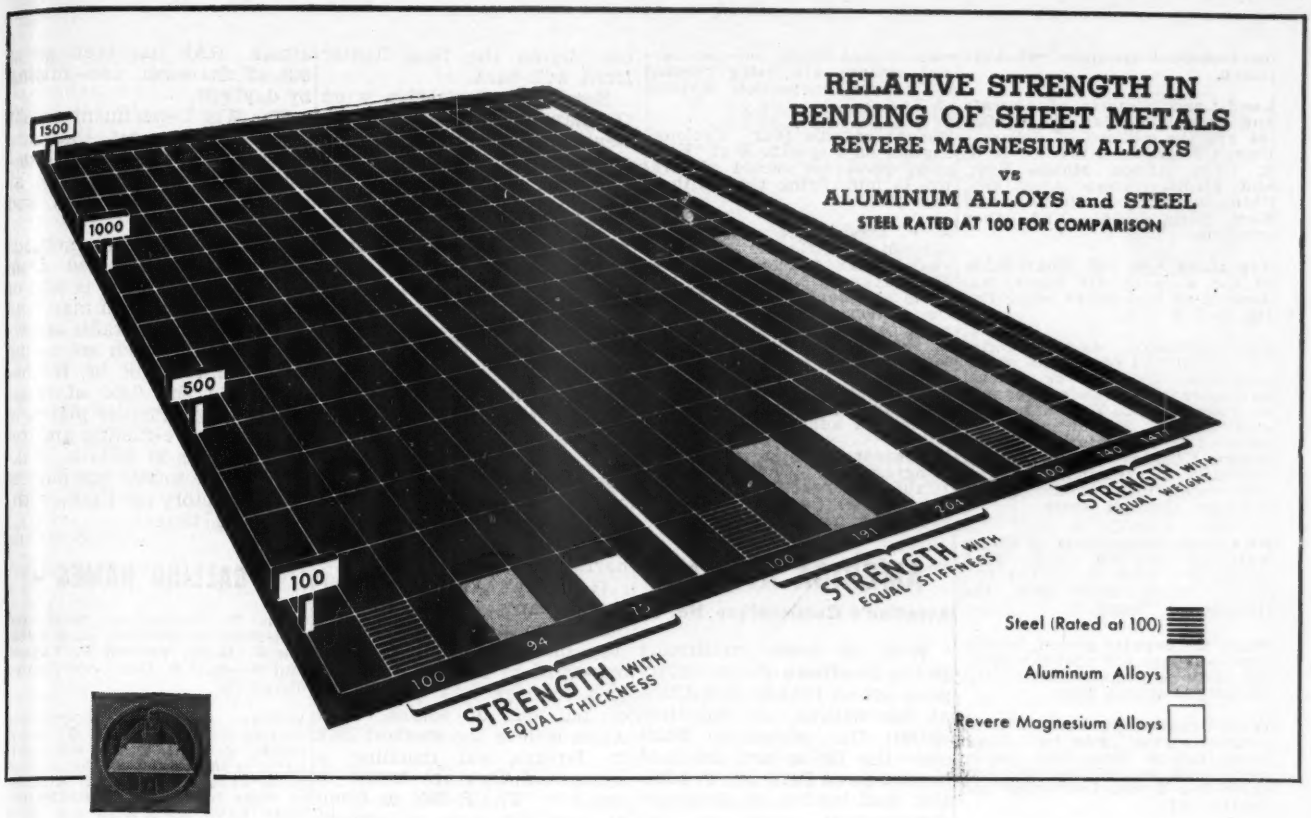
A pound of magnesium contains about 15½ cubic inches—a pound of steel 3½ and aluminum 10 cubic inches. On a pound for pound basis, you get 4½ magnesium units for one of steel and 1½ to one for aluminum. Magnesium goes further, and the further it goes the more you save. Remember that weight-saving means money-saving from the very beginning, in transportation and handling to and within your factory, in production processes, and in the end use of the product.

Lightness plus strength

Revere Magnesium Alloys offer strength as well as weight saving. With equal thickness, the sheet alloys have 75% of steel's strength in bending. To gain equal strength, the thickness need be increased only 15%, since strength in bending increases as the square of the thickness. To gain equal stiffness, an increase of only 65% in thickness is needed, since stiffness in bending increases as the cube of the thickness. With equal stiffness, the strength is double that of steel. With equal weight, bending strength is over 14 times that of steel. See the Chart.

Where to save with Magnesium

Transportation. Railroad cars, buses, trucks, trailers, aircraft. Will make it possible to haul heavier payloads in states limiting total weight on the road.



Hand-Operated Items. Anything pushed, pulled, lifted, carried. Vacuum cleaners and other household appliances; baby carriages; hand and portable tools; typewriters; instrument cases; luggage; hand trucks and dollies; mailing containers.

Reciprocating Parts. Anything that must be started, stopped, reversed in motion. Light weight and rigidity save power, reduce vibration.

Mill Products Available

Revere magnesium facilities are among the largest in the world. They offer sheet and plate, rod and bar, tube, extruded shapes, forgings and forging stock, in four different alloys.

May We Assist You?

The Revere Technical Advisory Service is at your command, ready to help you take full advantage of the remarkable qualities of Revere Magnesium Alloys. Let us show you how to use them to modernize and improve your own product, how production can be speeded up by increasing machining speeds, how to form, weld and rivet, simply, economically.

Write for your complimentary copy of the *new* 32-page booklet, "Revere Magnesium Alloys and the Light Metals Era," now coming off the presses. Presents the basic facts about magnesium, plus detailed technical data on the physical, mechanical and working characteristics of the Revere Alloys.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

MAGNESIUM-ALUMINUM DIVISION

Executive Offices: 230 Park Avenue, New York 17, N.Y.

Availability

Magnesium facilities were developed to help win the war. Now the supply is adequate and many applications other than in aircraft are being approved.

If your products can be improved by the use of Revere Magnesium alloys, we suggest you consult us about availability for civilian products.

on technical training rehabilitation.

Lend-Lease exports of aircraft and parts from Mar. '41 to May '44 are (in millions of dollars): United Kingdom 1,404; U. S. S. R. 1,124; Africa, Middle East, and Mediterranean Area 660; China, India, Australia, and New Zealand 565; and other countries 369.

Top allied Ace, Col. Pokryshkin of the Russian Air Force, has downed 59 planes—48 while flying Bell P-39's.

Comprehensive, 49-page brief on control and regulation of air avigation by state or federal government has been prepared by Judge Hal C. Thurman, general counsel for Braniff Airways for presentation before Public Utilities Commission of Colorado in hearing on rules and regulations governing air carriage through state.

PAA announces pilots of China National Aviation Corp., PAA subsidiary, have completed 20,000th supply flight over the Himalayan "hump."

Plans for popular priced, liquid-type compass for postwar civilian pilots are announced by the Sherrill Research Corp.

War Department reveals B-29 "Superfortress" has two bomb bays, rather than one. Large bomb load necessitated one bay extending forward of wing and another aft.

General Electric announces delivery of its 100,000th turbo-supercharger to U. S. government.

Col. Miguel A. Llona, Chief of Staff of the Peruvian Air Force, and a group of Peruvian officers have arrived in U. S. to tour AAF installations.

CAA had, as of June 30, 536 new route applications on file Proposed routes would add over half a million miles to present international systems.

Regulations to make it easier to "convert" military pilots to employment status on commercial airlines are being readied by general inspection division of CAA.

Wright reveals four "Cyclone" engines on a specific B-17 "Fortress" have set record of 1,134 hr. 15 min. flying time without overhaul.

A. F. Davis, vice pres. of The Lincoln Electric Co., has revealed that trucks flown over Himalayas are chopped into parts and packed for transport. On delivery, parts are welded back together. Beds of 2½-ton trucks are cut in two before loading into planes.

Technical committee has been organized by ASTM to function in field of adhesives.

In recent remarks to House, Congressman Chet Holifield (Calif.) proposed extension of airmail facilities to other-than-first-class mail.

AMERICA AT WAR

Aviation's Communique No. 33

With air power continuing in the forefront of the victory push across France, the Allies, at this writing, not only had driven the retreating Nazis over the Seine and smashed beyond freed Paris but in addition had landed an airborne-spearheaded army on the south coast of France.

Quickly established, the latter army is seen working toward junctures both with the armies to the north and with our forces driving to the top of Italy.

Increasing air power enables Allied forces to continue strategic bombing of German industrial works at pre-invasion strength while building up tactical support of the ground forces. AAF-RAF superiority has driven the Nazi fighter front well back.

Bomber concentration is on German oil production, the weak link in Hitler's aviation whose breaking may start the inevitable collapse. It is indicated that during the past four months, oil supply has been the ceiling on Luftwaffe activity.

Germany has been taking increased punishment due to Allied shuttle operations between Italy, England, and Russian bases. First shuttle runs recently were made by all-fighter formations. Fighter-bombers, which are taking over the function of dive bombers in the Army, and medium bombers will add their devastation increasingly as the great Anglo-Russian squeeze narrows the range.

Germany's soft spot is oil, and Japan's is steel for the building of ships. The Secretary of Navy estimates that one-third to one-half of Japan's tonnage has been sunk or put out of action. The Allies believe the weakest link in Japan's war machine is ships, and they are trying to break it. The B-29's, as often as they can save up enough gasoline from the trickle over the hump, are hitting at Nippon steel production.

There will be more gasoline very soon for the 20th Air Force. The new Burma Road carries more cargo than the old one did. But more important, the B-29's can strike from islands now in Allied hands, drinking gasoline right out of the tanker.

Martin B-26's not long ago made the first American night attack; RAF has been going out of character, too—hitting by daylight.

The War Department at last let out the secret that the Russians have been taking delivery of American planes at several bases in Alaska and Canada.

New weapons and methods are being unclassified from time to time. More is told of airmen's flak suits of mail, and supplementary metallic shawls and blankets which are saving lives. There will be further details in the field of radar before long. Fighter planes in Europe are re-fueling and reloading guns in 20 min., making shorter sorties but putting in satisfactory air time—without drop tanks.

★ CALLING NAMES ★

Juan T. Trippe is re-elected president of Panam, and **Preston F. Bush, Vernon F. Taylor,** and **Howard B. Dean** are elected directors.

William H. Miller, operations manager, and **Willis G. Lipscomb,** general traffic manager, have been elected assistant vice presidents of American Airlines in their respective departments. Both have been with AA since its organization as American Airways in 1930; prior to that both had been with predecesor companies. Four regional v.p.'s have also been named: **A. R. Bone,** Western Region, Los Angeles; **M. D. Miller,** Southern Region, Dallas and Ft. Worth; **L. W. King,** Central Region, Chicago; and **W. N. Bump,** New England Region, Boston.

Edward V. Whallon has been named district traffic manager for United Air Lines at Boston as first step in UAL's Boston expansion preparatory to establishment of direct service to that city. Meanwhile four staff

BLACKOUTS TO ORDER

For precise study of blackout reactions, subject (left) sits in cab of special centrifuge, Materiel Command aero-medical laboratory device, and readies himself for test run. He faces observer (right) who has telephonic communication with room from which apparatus is controlled by G. E. system. Floodlight in front of observer illuminates test subject for camera recording. To duplicate force of airplane pulling out of dive, causing blackout, cab swings outward, placing subject in position parallel to circle of plane described by body with head to center. Test can be stopped by subject, at will. Special instruments attached to subject record reactions. Included are electro-cardiograph, brain-wave recorder (seen on head), and photo-electric eye for measuring tissue blood volume, pulse, and respiration. Alertness and state of consciousness are determined by time required for subject to throw switches which turn off reaction-timing lights and buzzers on panel. (AAF Materiel Command photos.)

changes in Pacific Coast offices were made: **John Standish,** Oakland district manager, becomes Portland district manager, succeeding **William R. Thigpen** who is receiving a new assignment in the east; **Jack Misselhorn,** Sacramento district manager, succeeds Standish at Oakland; and **Max King** transfers from Seattle to Sacramento.

James L. Straight, formerly director of the Production Division of the AWPC, has been made Los Angeles manager for the Aircraft Manufacturers Council and its parent organization, the Aero Chamber of Commerce.

Jack Frost has been appointed assistant to **Lowell H. Swenson,** manager of the National Aeronautic Assn.

Ross Taylor has become UAL Akron district traffic manager. Miss **Norma E. Craig** becomes UAL's promotional advertising representative in N. Y. C.

James H. Wyld, research engineer of Reaction Motors, has been elected president of the American Rocket Society. Other officers: **Roy Healy,** vice president; **Dr. G. Edward Pendray,** secretary; **Cedric Giles,** editor of "Astronautics"; and **Dr. Samuel Lichenstein,** treasurer.

Maj. Vernon M. Dennison returns from Army to Penn-Central, to serve as coordinator of production scheduling in maintenance and overhaul.

C. Bedell Munro, Penn-Central president, has been appointed chairman of Airlines Div., National Industrial Information Committee.

W. H. MacLean, treasurer-controller of Curtiss-Wright, Louisville, has been elected president of the Louisville Control of the Controllers Institute of America, and **Laurence A. Smith,** controller of McDonnell Aircraft Corp., is named to the same office of the St. Louis Control. Lockheed's comptroller, **Dudley E. Brown,** was named second v.-p. of Los Angeles chapter.

Henry S. Stillwell, of University of Kansas Dept. Aeronautical Engineering, has been appointed head of newly-created Dept. of Aero Engineering at Univ. of Illinois.

Capt. R. S. Barnaby, USN, for the past year chief engineer for Naval Aircraft Factory, Philadelphia, has been made commanding officer of Naval Aircraft Modification Unit, Naval Air Materiel Center, Phila. This unit, until recently located in Philadelphia Navy Yard, took over Brewster plant at Johnsville, Pa., and will carry on prototype modifications, special development projects, and some production modification.

Gordon Dubberly, of Boeing Aircraft of Canada, was elected president of British Columbia Industrial Safety Council. Vice-presidents for coming year are: **Anthony Lumley** of Yarrows, Ltd., Victoria; and **James D. Forrest,** Burrard Drydock Co., Ltd. **S. G. Daniels,** of West Coast Shipbuilder, Ltd., was re-elected secretary-treasurer.

Mason Britton, formerly v.-p. of McGraw-Hill Publishing Co., has been named Assistant Administrator of Surplus War Property Administration, to have general supervision of disposal of all types of surplus property for which RFC is disposal agency.

Maurice H. Crim has been appointed to newly-created position of superintendent of commissary for Braniff Airways, and **Maxine Keir** has been named chief hostess for system.

Wesley J. Hennessy, supervisor of training program for engineering aides at Grumman, has been made assistant to Dean of Engineering, Columbia University.

William K. Swigert, manufacturing advisor, has retired from active service with Curtiss-Wright Corp., Propeller Div.

E. O. Locher has assumed general managership of Airplane Mfg. & Supply Corp., in addition to his duties as secretary-treasurer.

Earl R. Southee has been named manager of aviation section of Hilliard Corp., Elmira, N. Y. He comes to Hilliard from CAA, where he served as Ass't. Director of War Training Service.

Arthur Gordon Green, for past 28 yr. with Norton Co., has been appointed sales manager of Bay State Abrasive Products Co., Westboro, Mass.

Capt. Olaf S. Abrahamsen, PAA master pilot, established east-to-west PB2Y record of 19 hr. 39 min., some 2 hr. under previous time, between undisclosed British base and LaGuardia Field. "Coronado" carried 10 passengers, 2,899 lb. of mail, and crew of 9.

Edward L. Bertram, for 2 yr. on active duty as captain in Ordnance Dept., has returned to Automatic Transportation Co., division of Yale & Towne Mfg. Co., at Chicago, where he again becomes sales promotion and advertising manager.

Sherwood L. Gish has been made Northwest Airlines district traffic manager in Portland, Ore., where NWA will soon restore service.

Rudolf Beck has been made chief engineer of the American Instrument Div., Manning, Maxwell & Moore. **Albert W. Coleman** is appointed to new position of sales manager for Manning, Maxwell & Moore, Inc., and will headquarter in Bridgeport. **Paul M. Rolli,** former Pacific Coast rep, succeeds Coleman as Pacific Coast district manager. Other personnel changes: **L. E. Gebbart** becomes Mid-Atlantic district manager at Philadelphia, Pa.; **Charles Stephan** is manager of new Electro-Mechanical Div.; **Lee P. Stillman** becomes manager of Tulsa Products Div.; **James O'Connor** becomes sales engineer for Ashcroft Gauge Div.; and **E. M. Dunlap** becomes manager of distributor sales.

Frank E. Bell has been appointed technical service engineer for Hycar Chemical Co.

E. E. LeVan is elected president of Haynes Stellite Co., a unit of Union Carbide & Carbon Corp., succeeding late **Francis F. Gormely.**

E. J. DelVecchio has been made field sales manager Progressive Welder Co., and **Harry S. Rose** has been named sales manager for Detroit district.

Howard P. DeVilbiss has become president and general manager and **Allen D. Gutchess** becomes board chairman and active senior executive, DeVilbiss Co.

James R. Longwell has been made director of engineering and research for Carboloy Co.

Obituary

James C. "Bud" Mars, pioneer in ballooning and aviation. In 1892, he made his first public parachute leap from a balloon, and during 1901-02 he gave similar exhibitions on a world tour. He made his first solo flight in a Curtiss plane in 1908, and in 1911 gave Emperor Hirohito his first plane ride. During World War I, as a lieutenant in Signal Corps, he trained many pilots. In later years he built an airport and conducted an aviation school in New York.

Sadi Lecointe, veteran French aviator, whose flying activities date back to 1911. He established altitude and speed records, and in 1920 won Gordon Bennett Cup Race. In World War I, he tested planes for French government, and subsequently he held posts as Inspector General of Civil Aviation, and as Base Commander of French Air Force in Africa.

Nikolai N. Polikarpoff, prominent plane designer and Soviet official. He made many contributions in developing fighter planes and armament, also was wellknown for his design of a fabric-covered biplane adaptable for combat, hospital, and supply services. He received numerous decorations from USSR.

J. M. Miller, chief engineer, aircraft carburetor section, Bendix Products Div. He was a graduate of University of Cincinnati, served in army during World War I, and later was carburetor engineer with experimental aviation engineering division at McCook Field. In 1927, he joined Stromberg Carburetor Co., which later became part of Bendix Products Div.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Big-name companies, having permanent-career jobs to offer, are luring key men out of aircraft plants, some intentionally, some inadvertently. The departing key men fear being dropped when stop orders come; other companies want their aircraft experience in materials and their fresh viewpoint on durable goods design. The problem is so serious that some big aircraft companies have appealed to Washington.

Stunt boys will be boys, and CAA is already after them. Returning service pilots are crashing themselves in borrowed grasshoppers. Fear of a new stunt era is one reason why official recommendations are made against the sale of surplus military training planes.

A lot of people use horses, or boats, or automobiles, yet they have no common interest. Some air legislation experts in Washington are beginning to think there is no point in trying to wrap up all air law in one bill. Maybe there should be a private pilots act of 1945, then a special fixed base operators act, and so on.

Once in a while war wipes out something at the right time. F'rinstance a program was getting started in '41 to put air location marks on roofs, then the war came along and it was erased so the Germans and Japs who were coming over here couldn't find Chicago. Thus the field's now entirely clear for a more advanced form of marking program—and it looks as if the idea for a coordinated "latitude and longitude" system of "air addresses" via contact landmarks will be okay. CAA tends to favor it.

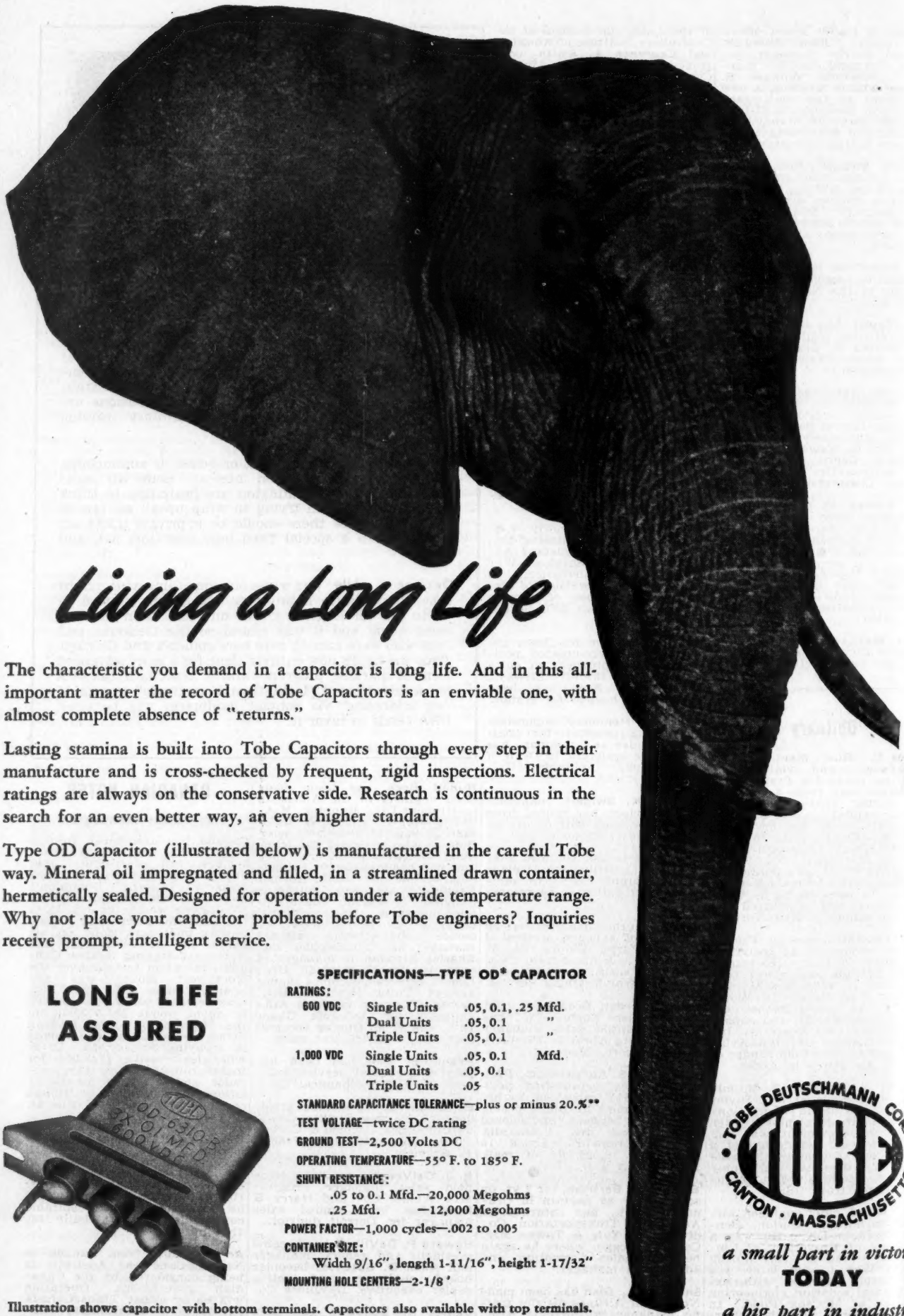
★ CANADIAN NOTES ★

By James Montagnes

Canada has announced that it is acquiring, for nearly $120,000,000, full sovereignty over airfields built as a wartime measure in the Dominion's northland. Of this sum nearly $77,000,000 was being repaid to the U. S. for permanent installations and work done on air bases on the Northwest and Northeast Staging Routes. Canada's intention to take over the Northwest Route was announced some time ago. Figures released show that the U. S. spent about $35,000,000 on the Hudson Bay and Hudson Strait route, of which Canada is repaying $27,460,000. U. S. will also receive $548,000 for installations at Goose Bay, Labrador, and $3,700,000 for installations and work done at Mignan on the north shore of the St. Lawrence River.

Returning Canadian airmen have been advised by Munitions & Supply Minister Howe not to buy used military aircraft to set up commercial air routes. He stated war veterans would be wiser to purchase suitable commercial aircraft built for that purpose.

An air route from Canada to New Zealand and Australia is being considered by the Canadian government. Operation will be by either Trans-Canada Air Lines or a subsidiary company of the government-owned transport concern.



Living a Long Life

The characteristic you demand in a capacitor is long life. And in this all-important matter the record of Tobe Capacitors is an enviable one, with almost complete absence of "returns."

Lasting stamina is built into Tobe Capacitors through every step in their manufacture and is cross-checked by frequent, rigid inspections. Electrical ratings are always on the conservative side. Research is continuous in the search for an even better way, an even higher standard.

Type OD Capacitor (illustrated below) is manufactured in the careful Tobe way. Mineral oil impregnated and filled, in a streamlined drawn container, hermetically sealed. Designed for operation under a wide temperature range. Why not place your capacitor problems before Tobe engineers? Inquiries receive prompt, intelligent service.

LONG LIFE ASSURED

SPECIFICATIONS—TYPE OD* CAPACITOR

RATINGS:

600 VDC	Single Units	.05, 0.1, .25	Mfd.
	Dual Units	.05, 0.1	"
	Triple Units	.05, 0.1	"
1,000 VDC	Single Units	.05, 0.1	Mfd.
	Dual Units	.05, 0.1	
	Triple Units	.05	

STANDARD CAPACITANCE TOLERANCE—plus or minus 20.%**

TEST VOLTAGE—twice DC rating

GROUND TEST—2,500 Volts DC

OPERATING TEMPERATURE—55° F. to 185° F.

SHUNT RESISTANCE:
.05 to 0.1 Mfd.—20,000 Megohms
.25 Mfd. —12,000 Megohms

POWER FACTOR—1,000 cycles—.002 to .005

CONTAINER SIZE:
Width 9/16", length 1-11/16", height 1-17/32"

MOUNTING HOLE CENTERS—2-1/8"

Illustration shows capacitor with bottom terminals. Capacitors also available with top terminals.
*Data sheets showing complete code number for units having a specific capacitance value and voltage ratings available on request. **Other tolerances available.

TOBE DEUTSCHMANN CORP.
TOBE
CANTON • MASSACHUSETTS

a small part in victory
TODAY
a big part in industry
TOMORROW

July Aircraft Unit Production Down to 8,000; War Dept. Orders New Emphasis on Big Craft

. . . Industry advises Congress regarding war-to-peace steps . . . Chamber's move against plane-dumping . . . Will plants come inland? . . . How ACCA is girded for policy job . . . G.E. to "up" jet turbine production.

The Aircraft unit production slump of 5.9 percent—from 8,049 in June to 8,000 in July—was caused by hot weather, holidays, and a continued manpower pinch. War chiefs were neither surprised nor alarmed about the few planes they didn't get, but such letdowns, symptomatic of complacency, upsets them. Airplane production has been stabilized at about 8,000 units per month. Output for August is scheduled at 8,274, a reduction of 3 percent under the previous program, mostly in small planes.

Today, manpower and materials resources rated at the equivalent of two or three thousand more smaller units per month are going into four-engined bombers, which are now rolling out at a rate well above 1,000 per month. Four delivered B-29's were not counted in the July total, because of new tally rules.

Although manpower is getting tighter, many green workers have improved their efficiency, and the technique of job breakdown for simplicity is helping boost pounds-per-worker. Labor turnover, growing worse for two years, seems to have leveled off. In Apr. 1942, it was 3.72 per 100 workers per month; the Apr. 1943 figure was 4.62; Mar. 1944, 4.57; and Apr. 1944, 4.32.

New Emphasis on Big Craft

The War Department has announced changes in the aircraft production program necessitated by the shifting emphasis from land and amphibious operations to air war. The changes call for increased production of large bombers and big troop transports. Output of P-47's, B-24's, and C-46's has been cut in favor of increased production of the B-29, "Superfortress," and the new huge Convair B-32 bomber. Also announced were labor re-allocations involving release of 100,000 workers by the end of '44, 20,000 of whom will be released immediately for other work.

Industry Advises Congress On War-to-Peace Steps

Involved problems of transition from war to peace confronted Congress upon its return from vacation. On hand to advise Capitol Hill concerning aircraft, biggest single arms category in the war, was the Aeronautical Chamber of Commerce. Four leaders of the industry—E. E. Wilson, vice chairman of United Aircraft and chairman of the Chamber; Harry Woodhead, president of Consolidated Vultee; Joseph T. Geuting, vice president of General Aircraft; and J. Carlton Ward, Jr., president of Fairchild—presented main provisions of the plan before the Senate War Contracts subcommittee.

The industry recommended peacetime maintenance of strong airpower backed by continuing technical development, also unemployment compensation for a majority of the 2,100,000 workers in aircraft, and free transportation home. On the other hand, the industry opposes separation pay (while labor leaders demand it).

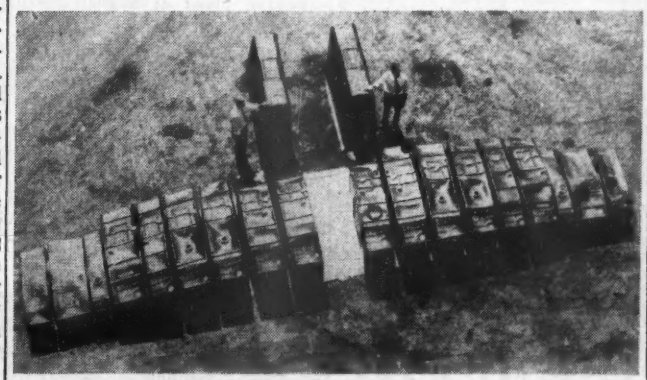
Further recommended: Immediate use of engineering tools, and plans for basic development of postwar products; right of manufacturers to buy government plants, or manage them as stand-bys for any emergency; and handling of all policies on disposal of surplus planes and equipment by one agency to be created by legislation. (It is noted that the Surplus War Properties Administration, under RFC, now handling surplus planes, is executive agency).

In addition, the industry stated that plane sales should be handled by manufacturers who originated design; all classes of trainer planes should be given to schools and colleges for military training only; major components of planes abandoned overseas should not be returned because many of them are "dangerous" and unsuitable; military planes of new design should be continued in production, and development of experimental types should likewise be continued; and cutbacks in production should be coordinated between Army and Navy to help fill up capacity released by either service, with cutbacks to be effective first in temporary facilities, such as those of the automobile industry, which have other markets awaiting them.

Finally, 60 to 120-day notice should be given on cutbacks, and cutbacks should not interfere with future production of types of aircraft still in demand by the military; light liaison type planes should be sold, but not to dealers for speculation, it being held that trainers are not suitable for, and should not be sold to, civilians; and also regulation should be relaxed to the point that personal flyers will be no more restricted than are motorists.

Chamber's Move Against Plane Dumping Favored

The Aero Chamber's recommendation that the industry be protected against unloading of surplus planes is supported by Under Secretary of War Patterson, who told the Senate War Contract Committee that surplus planes should be sold "in a way that will not have a bad effect on the markets of the aircraft industry."



DESIGN FOR DISTANCE

Compact arrangement of 20 Goodrich wing and bomb bay self-sealing cells are shown in this typical layout for a smaller bomber, illustrating thorough fuel-space utilization for long range operation. Each cell is exactly tailored to fit specific compartment. Many more cells are employed in larger craft.

Artemus L. Gates, Assistant Secretary of the Navy for Air, agreed with Patterson and with the Aero Chamber on most points. He called for maintenance of peacetime airpower; for maintenance of certain war plants as essential stand-bys; maintenance of overseas air bases; preservation of a strong aircraft manufacturing industry; and also orderly expansion of domestic and international air transport.

How ACCA is Girded for Policy Job

For more than a year the aircraft industry has been working toward establishment of a strong trade organization which could serve as a vigorous spokesman in the troublous shift from war to peace. The Aircraft War Production Councils were not legally constituted to do a policy job.

The Aeronautical Chamber of Commerce, with strong new leadership, is being reorganized—to handle the transition work and the important initial peacetime leadership.

ACCA, as newly set up, consists of two Councils: The Aircraft Manufacturers Council, and the Personal Aircraft Council. AMC is in two sections, on each coast. Harry Woodhead, of Convair, is chairman of the Western Regional Executive Committee, and R. E. Gillmor, of Sperry Gyroscope, is chairman of the Eastern Committee. Membership of both Councils totals 17 major companies. Each Regional Executive Committee meets once monthly. AMC has seven authorized committees.

Just now AMC is primarily concerned with termination and reconversion. A Contract Termination Unit has been formed, which will work with government agencies involved. Three specialists have been assigned to full time with this unit.

The Personal Aircraft Council succeeds the earlier Personal Aircraft Committee, which is now chiefly concerned in developing a small airfield program.

The former departments of the Chamber have been reorganized as service bureaus: Economic, technical, traffic, etc.

The Airworthiness Requirements Committee of the Aero Chamber of Commerce is developing a program of international uniformity of airworthiness requirements so that aircraft may move freely from one country to another. Conditions which should gov-

ern admission of foreign aircraft into the United States for sale to private purchasers, also regulatio of foreign airlines operating into and within this country, are being considered.

Will Plants Come Inland?

Long controversy is expected on the question of locating aircraft plants inland for easier defense against any future attack on this continent. Some influential officers in both Army and Navy are favoring the move; some oppose it. Managements of the inland plants cite plentiful rural manpower, easily shifted to aircraft work, with a minimum of union trouble. But the parent companies of nearly all inland branches are on the coasts and will want to keep their businesses there. In a showdown, Army and Navy, if united for inland location, would have the advantage over Congress, which might be expected to be divided along state lines.

G.E. to "Up" Jet Production

Broader developments in the jet propulsion field are evidenced by General Electric's announcement that its second largest wartime plant, built two years ago for manufacture of war equipment and no longer required, is being converted for the production of jet propulsion aircraft turbines. The plant has 600,000 sq.ft. of floor space. However, since output here will not be sufficient to meet government needs, G.E. has turned over drawings and specifications to another large corporation (unnamed) which has been manufacturing aircraft engines.

Plan for Worker Benefits

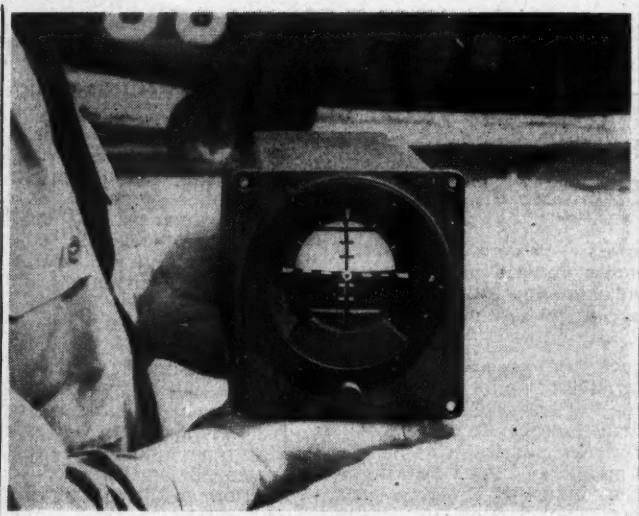
Plan for postwar benefit of veterans and unemployed war workers has been outlined by Col. Willard F. Rockwell, board chairman, Timken Detroit Axle Co. Proposed is system of withholding, from gross income (after taxes and normal profit and before renegotiation) an average week's wage for each month of continuous employment, with a maximum of 24 wk. wage for employees or ex-employees in service who have worked 2 yr. or more.

★ ASSEMBLY LINES ★

Weatherhead Co., Cleveland produces its 160,000,000th aircraft fitting, averaging more than a million a week since Pearl Harbor.

Pratt & Whitney rolls final 600-hp. single-row "Wasp" engine from assembly lines in East Hartford, switching facilities to production of higher-power units.

WPB figures show Convair's Ft. Worth plant has reduced B-24 man-hours by a total of 56 percent.



GYRO VISUALIZES PLANE'S ATTITUDE

New Sperry attitude gyro provides pilot with precise position indications through 360 deg. of roll and pitch by giving visual indication with reference to earth's surface in all possible attitudes of maneuvers. Particularly valuable in complicated aerobatics, gyro is adaptable to all types of planes. Reference pattern marked on stabilized sphere with luminescent paint is visible through masked opening of case. Indicating sphere has white upper half and black lower half. Contrasting color latitude lines, with inscribed short 10-deg. marks, increase concept of spherical surface and indicate pitch angle. Contrasting color vertical meridian line gives roll angle indication with reference to fixed index on mask. Black and white lateral lubber line across center of mask opening provides basic pitch index for reference to pattern of sphere. (International News photo.)

Chandler-Evans Corp. delivers 50,000th Ceco carburetor to AAF. Plant was started only about two years ago.

Final Douglas SBD "Dauntless" —5,936th—rolls from El Segundo plant's assembly lines to be succeeded by faster, longer range dive-bomber.

Boeing opens new $650,000 employee cafeteria and food center at Seattle plant.

Willys-Overland gets contract for approximately 5,000 gas tanks, some 1,000 C-46 vertical fins, and undisclosed number of carburetor air intakes for SB2-C's. Output of F6F landing gears has been upped 30 percent during past six months, primarily through change in welding process.

Hycar Chemical Co. cuts synthetic rubber prices 10 percent —fourth drop since Aug. 1941.

Navy has selected Lawrance Aeronautical Corp., Linden, N. J., to manufacture two different types of automatic pilots. Meantime, Pres. Rowland Burnstan states the company has contracted to do research work for various other governmental agencies.

AWPC West announces drafting of a "Standard Quality Manual" providing uniform set of definitions covering quality of aircraft parts and materials. It will be used by all major West Coast airframe companies and their outside production sources. Illustrated by drawings, photos, and cartoons, handbook is 188 pages in length.

Final B-25 "Mitchell"—the 3,208th—recently came off line at North American's Inglewood, Calif., plant. Facilities now go to P-51 "Mustangs."

Eclipse Machine Div. of Bendix will take over operation of U. S. Navy - Remington - Rand "N" plant at Elmira, N. Y., as agency for AAF, in order to expand production of B-29 equipment. New designation of facility will be Eclipse Plant No. 3.

★ FOR THE RECORD ★

Eagle Parachute Corp., Lancaster, Pa., has appointed Lynn-Fieldhouse Advertising Agency, Wilkes-Barre, Pa., and New York City, its advertising and merchandising counsel.

His own office as consultant economist, in Heurich Building, 1627 K St., N. W., Washington (6), D. C., has been established by John Howard Payne, former manager of economic development of Aero Chamber.

Atlantic Refining Co. has completed new high octane catalyst cracking plant at Breeze Point refinery, Philadelphia.

Timken Roller Bearing Co., Steel & Tube Div., Canton, Ohio, has appointed Brace-Mueller-Huntley as sales representative for its stainless steels.

John S. Barnes Corp. has moved eastern sales office from 250 W. 57 St., N. Y. C., to Industrial Office Building, 1060 Broad St., Newark (2), N. J. E. C. Hawkins continues in charge.

Whiting Corp., Harvey, Ill., has appointed Cardinal Supply & Mfg. Co., Sunderland Bldg., Omaha, its Nebraska and Western Iowa sales representative for aviation equipment, cranes, foundry equipment, and metal working machinery.

Western Electric Co. has leased Lane Bryant Building, 529 W. 42 St., N. Y. C., for manufacture of military electronic equipment. H. F. Snyder, transferred from Bayonne & City Line plants, is superintendent of new plant.

Pacific Railway Equipment Co., Los Angeles, has changed name to Preco, Inc.

B. F. Goodrich Co.'s new chemical division is located in Rose Building, Prospect Ave. & E. Ninth St., Cleveland. W. S. Richardson, formerly of company's Akron offices, is general manager.

DeBothezat Fan Div., American Machine & Metals, Inc., has moved New York district offices from 100 Sixth Ave. to Woolworth Building, 233 Broadway, New York City. Subsidiary, U. S. Gauge Co., is also located at new address.

New companies: Day Aeronautical Instruments, Inc., New Haven, Conn., E. W. Day, president; Rose Research Corp. (aircraft), New York.

Monarch Engineering & Mfg. Co., Baltimore, Md., has been purchased by Fisher Furnace Co. Combined headquarters and manufacturing facilities will be in Fisher's Chicago plants.

Walter Kidde & Co., Belleville, N. J., has opened new sales and engineering office at 9507 Santa Monica Blvd., Beverly Hills, Calif. J. M. Noble, former manager of company's aviation department, is district manager in charge of new office.

Vickers, Inc., has established a West Coast test and service center in Beverly Hills, Calif., thus obviating necessity of returning units to Detroit plant for inspection, test and repair.

★ KNOW-HOWS ★

Nubun, a new synthetic latex rubber insulation, modified from basic Buna-S polymer, has been introduced by U. S. Rubber Co. for covering electrical conductors. Stated to be perfectly centered, it has high insulation qualities for its diameter, coupled with resistance to aging and destructive forces, due to the latex process, which, says company, does not affect material's strength. Product is reported to retain 80 percent of its tensile strength and 85 percent of its elongation after 96 hr. aging in an oxygen bomb, while its insulation resistance constant K is put at 54,000 after submersion in water at room temperature.

Toolite, synthetic thermo-setting plastic substitute for metal in many parts of dies, jigs, and fixtures, has been originated by Emric W. Berger, of Convair. Material, it is reported, may be machined as accurately as metal, while having cutting facility of wood, with compressive strength up to 20,000 psi. Also announced are Metlbond, metal-to-metal or metal-to-plastic glue, and Glaco, a paint-like rubber sealing compound adaptable to self-sealing tanks.

Climb-milling with single Carboloy fly cutter increases output several hundred percent on nichrome rocker arms, says Carboloy Co. Feed is 7 in. per min. and cut ¼ in. deep. Cutting speed of 550 sfpm. is used, and finish is reported improved even after 1,500 pieces are turned out.

Glenn L. Martin now uses modifications of Farnham roll forming machine to eliminate scrap, reduce operating hazards, and enable semi-skilled help to be used in place of experienced operators. Chief changes are substitution of micro foot switch for pull rope, solenoid brake to prevent coasting, and remote safety stops designed to permit control from any point on machine. Invented by Paul H. Merriman, this change is stated to highly expedite production.

ON STRONGER, SAFER TIRES

UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE · ROCKEFELLER CENTER · NEW YORK 20, N. Y.

THE SKYFREIGHTER WEIGHS IN!

NEWEST addition to American Airlines Flagship Fleet is the Skyfreighter, carrying a useful load of 8826 pounds over American's transcontinental route.

The Skyfreighters are among the twenty-five planes now being returned to American Airlines by the Army and are actually the Flagship Skysleepers which the Army took over in the spring of 1942. They have been put through a complete conversion program by American to provide facilities best adapted to carrying cargo based upon American's long experience as an air cargo carrier.

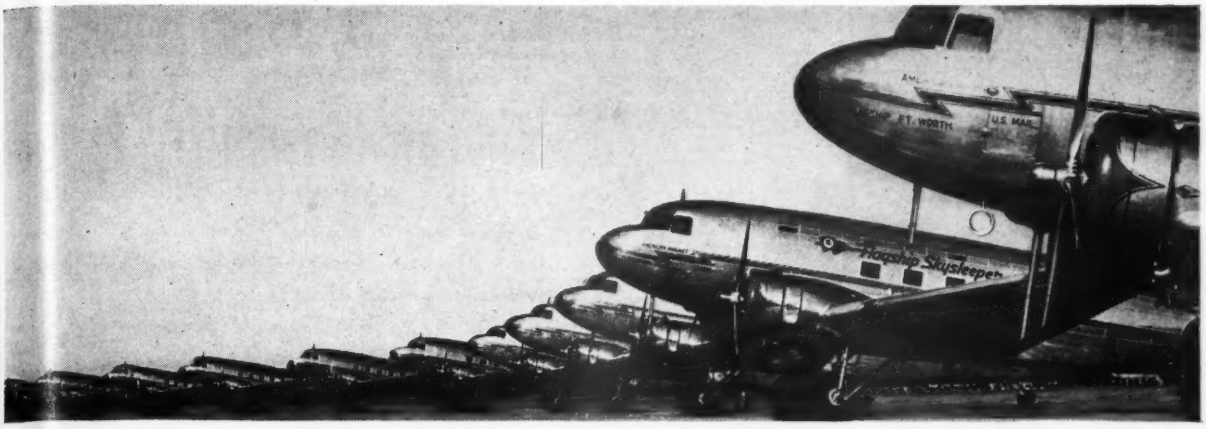
Here a Skyfreighter is officially weighed-in before she starts on her maiden flight. With scales under each of the landing wheels and another at the point from which the ship is suspended, the job is done quickly and easily. Regular weighing is important because airplanes, too, grow heavier as they grow older.

From July, 1941 to June, 1944 the average useful load carried by American Airlines Flagships has increased more than 50%. This extra load, made up of passengers and cargo, means extra work for tires. It makes tire quality and tire care more important than ever.

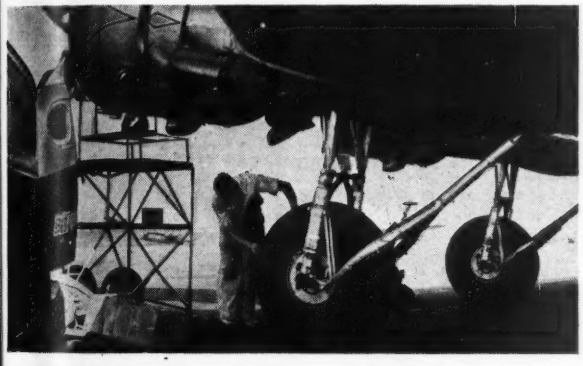
BY READING THE WEIGHTS recorded under each landing wheel and at the point of suspension, the total is quickly calculated. With every ounce of pay load needed for wartime cargo, accurate weighing is more than ever necessary.

1230 SIXTH AVENUE **UNITED STATES**

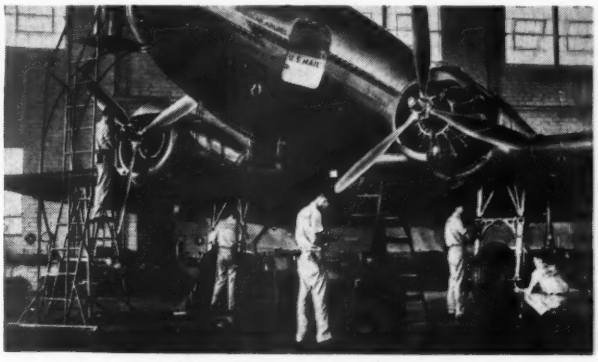
HOW AMERICAN AIRLINES CONSERVES TIRES WHILE ITS 50 PLANES DO THE WORK OF 82!



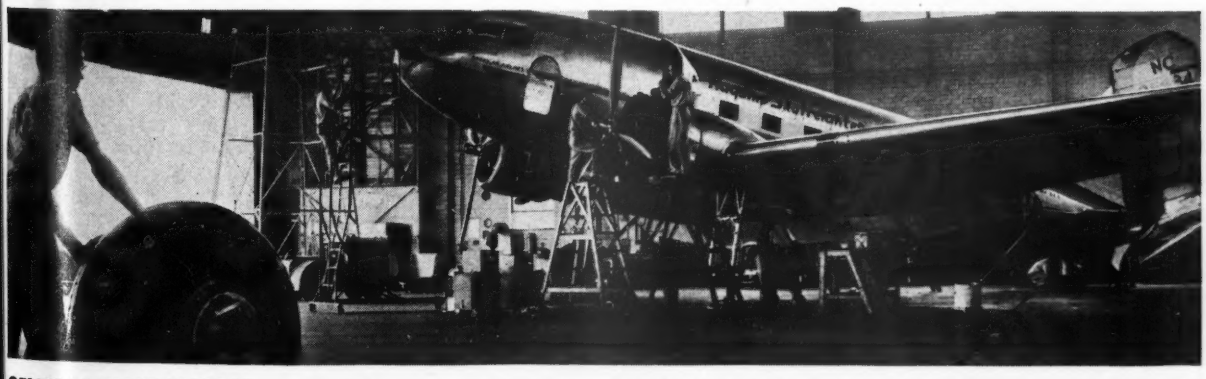
IN JULY, 1941, American Airlines operated 82 planes, a daily average of 7 hours and 39 minutes. In June, 1944, the Flagship Fleet consisted of 50 planes, with each plane scheduled for 13 hours active service every day. In 1941, the 82 planes turned in 605 hours of scheduled service. In 1944, the 50 planes worked 650 hours. That's one big reason why American has a maintenance department of over 3000 men and women...to keep the Flagship Fleet always at peak efficiency.



SERVICE INSPECTION...Whenever a Flagship rolls up to an American Airlines Terminal, one of the regular procedures followed by the ground crew is to give the tires the "once over" and report any signs of trouble at once.



LINE (OR BASE) INSPECTION...When the Flagship reaches its final terminal for the day, radio equipment, fuel and oil are checked. Landing gear, fuel, hydraulic and electrical systems and other vital parts are inspected.



GENERAL INSPECTION...At general inspection, every Flagship is checked over to the last detail by expert mechanics skilled in each specialized operation. Wheels are removed and tires, brakes and axles inspected. Where necessary, tires are removed and checked inside and out. Injured tires are returned to the manufacturer for repair. Smooth tires are returned for new treads. Under this carefully organized and rigidly supervised procedure tire failures at American are practically a thing of the past.

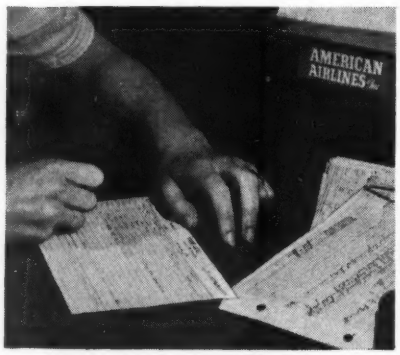
RUBBER COMPANY ROCKEFELLER CENTER • NEW YORK 20, N. Y.

WITH FLAGSHIPS LANDING on an average of once every hour instead of once in two hours and with pay loads 50% greater than in 1941, these U. S. Royal Airplane tires have a bigger job to do than ever before—and they are doing it!

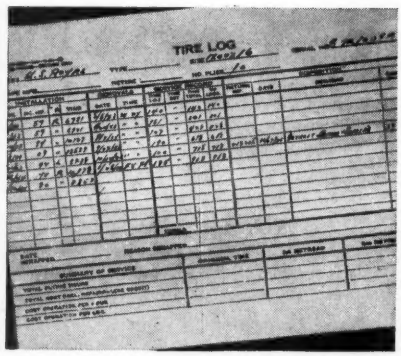
Life Line
OF A U. S. ROYAL
on the Flagship Fleet

Every tire that ever flew on an American Airlines Flagship has its own life line or Tire Log filed away where it can be referred to instantly. From the day that a 17.00 x 16 U. S. Royal Airplane tire is mounted on a Flagship until it is removed for recapping and finally discarded after having given its full service, the Maintenance Division of American Airlines keeps its life history hour by hour and plane by plane.

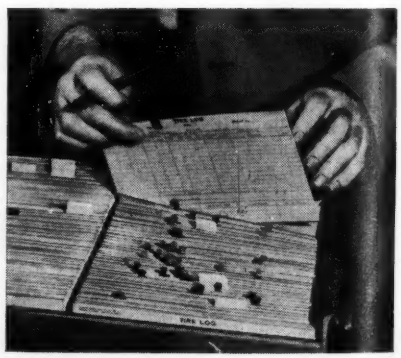
As synthetic rubber airplane tires with bodies of rayon replace natural rubber tires, the backlog of test experience already accumulated by American and recorded on Tire Logs will be of vital importance to airplane tire manufacturers. Benefiting from data like this, U. S. Airplane Tire engineers are finding new and better methods and materials to build lighter, stronger, safer tires.



IN THE RECORD SECTION of American's Maintenance Department, every tire has its own Tire Log. From the ship's log, the record clerk transposes each step in the tire's life from original installation to final removal.



THIS IS THE LIFE LINE of a U. S. Royal that made better than 700 landings before it was sent to the "U. S." Tire Factory at Detroit for recapping. If the tire body is still in good condition, a new tread will be applied and the tire put back in service.



THERE IS A TIRE LOG on file for every tire that ever flew on an American Airlines Flagship. From these records, data are supplied to airplane tire makers helping them to design stronger airplane tires to carry the greater loads of today and tomorrow.

SERVING THROUGH SCIENCE **TO SPEED THE VICTORY**

UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE • ROCKEFELLER CENTER • NEW YORK 20, N. Y.

Approval of Northwest Airlines Extension Will Add Fourth Transcontinental Service

. . . Finish AA-AEA hearings . . . PAA plans low-rate postwar service to S.A. . . . Notes on airline seat impasse . . . CAA recommends doubling of nation's airports . . . Joint Airport Users meet in Capital.

If CAB acts favorably on the examiner's recommendation and approves Northwest Airlines for extension from Milwaukee to New York (via Detroit and Cleveland), a fourth transcontinental airline will have been added to the domestic airway system. Trans-Canada, which will carry a fair portion of U. S. business, especially vacationers, may be regarded as a fifth coast-to-coast service.

Northwest applied for extension from Chicago to New York in 1941, and was turned down by the Board because Chicago was (and is) a traffic bottleneck, and because it decided the proposed service was not necessary in the public interest and would cost the government $400,000 a year. The examiner now approves the application because he finds that (1) the eight northwest states will retain much of their war-acquired industry; (2) a change of planes and one hour eastbound and two hours westbound can be saved between New York and Seattle; (3) the Chicago bottleneck is not an issue, since that city isn't on proposed extension.

Finish AA-AEA Hearings; Decision Awaited

Hearings by CAB on joint application for purchase by American Airlines of a controlling interest in American Export Airlines have been completed. The examiner will make a recommendation to the Board in a few weeks, for or against. Export had been ordered by the board, long ago, to divest itself of control by Export Steamship Co., in accordance with law. The proposed merger with American Airlines was Export's reply. Favorable action by the Board is predicted.

Export, operating to Foynes, Ireland, over North and South Atlantic routes, has a certificate to Lisbon, and has filed for routes via the Mediterranean to Bombay and via Brazil to South Africa. The Board's decision on the Export-American merger will have no bearing on foreign policy as between a single foreign service and free competition. Reports to that effect are erroneous.

Low-Rate Postwar Service To S. A. Planned by PAA

Revealed in New York were PAA's postwar plans for expansion of its Latin American services whereby travel time to Buenos Aires would be reduced from the present 91 hr. 15 min. to 21 hr. 25 min., while time to Rio would be scheduled at 19 hr. 50 min. rather than the present 66 hr.

Postwar addition of a new fleet of 300-mph.-plus land craft, one type to carry 108 passengers and a smaller model to accommodate 60 passengers, would found the expedited service. Addition of the new planes, states PAA, will increase the company's present passenger-mile transport capacity in Latin America more than 100 times.

It was not announced which company, or companies, would make the new planes.

New air fares on the long distance routes would then be brought as low as 3½c. per mile, according to the company, and it sees per-ton-mile rates for cargo averaging 25.4c., with slow-classification air freight destined for the most distant centers even going as low as 10c. per ton-mile.

Earlier in a New York meeting called by ATA's Air Cargo, Inc., and attended by airline, Railway Express Agency, and CAA representatives, views were also expressed on the lowering of air cargo rates following the war. With new airline equipment, rates were seen dropping to about 30c. per ton-mile, and there was further belief that cargo would subsequently be air-carried between 5 and 10c. a ton-mile.

Re "Chosen Instrument"

A new five-man working committee of the Airlines Committee for United States Air Policy has been set up to increase pressure on the government against PAA's "chosen instrument" proposal. A hard fight over this question continues in Congress, with the "free competition" side leading by a narrow margin. Until and unless Congress changes the law, the CAB is bound to support competition among the airlines "in the public interest."

Foreign Policy Picture

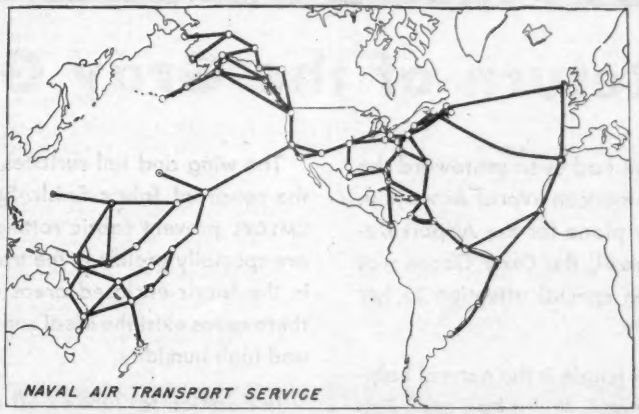
There has been no material change in the long effort to establish foreign policy with reference to reciprocal rights of entry, right of passage, cabotage, and use of bases. At present the United States and England are working under a 15-yr. agreement reached in conferences in 1935-1937, between this country, Canada, Ireland, and the United Kingdom. Any nation can give 60 days notice of intent, and withdraw in 2 yr. The agreement is informal and is not codified. One provision is that the carriers of England and the United States shall make no more than two weekly trans-Atlantic round trips.

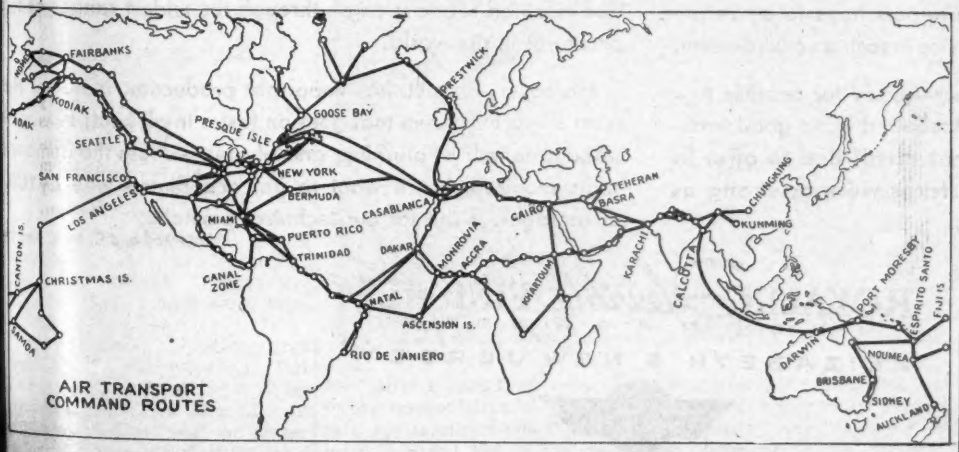
Notes on the Airline Seat Impasse

The scramble for seats on the airlines at last ended in a showdown between the Office of Defense Transportation and the Army. J. Monroe Johnson, ODT director, sent a letter to Robert A. Lovett, assistant Secretary of War, suggesting that strict limitations called for by the President in his memorandum to the Army in May, 1942, are not being adhered to.

Not long ago the Post Office Department won its point for more transport facility for airmail on scheduled delivery.

(*Continued on page* 215)





GLOBE-SPANNING ROUTES OF OUR MILITARY AIR SERVICES

Based on recently released details, these maps depict worldwide scope of Army and Navy air transport operations. NATS map (top) shows Navy's routes and ATC map (above) traces Army's global coverage.

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A SHORT TIME AGO her upturned nose had been set toward the West and the repair shops of Pan American World Airways in New York. After a year as a survey plane for the Airport Development Program in Equatorial Brazil, the Gray Goose was slated for a complete overhaul with special attention to her fabric covered wing and tail surfaces.

For the steaming heat of a tropical jungle is the natural habitat for fabric consuming micro-organisms, and it had been Pan American's experience that many Clippers have to be recovered after as little as four months' service in such an environment.

But now the Gray Goose was back—ready for another tour of duty—and the only repair she had required was a good washing. **After a year of taking all that Brazil had to offer in heat and moisture her fabric surfaces were as strong as when she left the assembly line.**

The wing and tail surfaces had been finished with EMYCEL* the rot-proof fabric finish. Special fungicides incorporated i EMYCEL prevent fabric rotting caused by fungus spores whic are specially prolific in the tropics and which propagate readil in the fabric-enclosed areas of wings and control surfaces. I these areas exist the ideal conditions for fungus growth—warmt and high humidity.

In addition to fighting off mildew, EMYCEL'S super flexibilit had retained fabric strength through the widest ranges of tem peratures in the world.

Moreover, EMYCEL has important production features. Her is an all-spray system that goes on faster in all kinds of weathe without danger of blushing, and always reduces the number o coats required. You'll want to get acquainted with EMYCEL' advantages. Write for our technical portfolio.

*Patented and C. A. A. approve

ROXALIN *Flexible* FINISHES
INCORPORATED
ELIZABETH • NEW JERSEY

WATCH ROXALIN IN AVIATIO

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CAA Recommends Doubling Of Nation's Airports

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Promotion and support of a broad program for airfields grows apace. Membership of the Chamber of Commerce of the U. S. has voted in favor of a national federal-aid airport system, where federal funds "should be matched by at least equal amounts of state or local funds." Eleven policies are listed. Further, Maury Maverick, chairman of the Smaller War Plants Corp., has urged a super-highway and airport plan wherein airports would be located at major intersections of the transcontinent routes. In addition, several large oil companies have plans under consideration for service stations which would care for civil flyers.

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(Continued bottom page 217)

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Top Quality FASTENERS

. . . to help you build
top quality planes . . .
Cleveland AIRCRAFT BOLTS

CLEVELAND
Top Quality
FASTENERS

The Cleveland Cap Screw Company

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ALLOY AND AIRCRAFT PARTS DIVISION

MADE BY THE ORIGINATORS OF THE KAUFMAN PROCESS FOR GREATER STRENGTH AND ACCURACY

Republic Aviation Corp. reports net earnings of $1,808,176 equal to $1.84 a common share for the six months ended June 30. Net sales for the half-year were $219,797. Censorship prevented disclosure of Republic's 1943 sales. The six months earnings are before renegotiation.

Curtiss-Wright Corp. pamphlet report for 1943 disclosed that on Dec. 31, 1943 the company had current assets of $740,198,019 ($130,354,000 of it in cash) against current liabilities of $673,548,000. Postwar reserves of $9,088,000 were set aside last year, bringing the total amount of such reserves to $24,311,000. The company's airports were written down to $3,017,000, and efforts to liquidate these properties will continue.

Braniff Airways reports net profits for the first six months of $319,353 or 32c. a share against $425,192 or 42c. a share in the like 1943 period. The 1943 profits did not include the retroactive mail pay adjustments, which would have reduced net substantially for that period.

Packard Motor Car Co. has reversed a previous decision and decided to continue in the aircraft engine field after the war. Company officials estimate that the marine and aircraft engine divisions will employ about 6,000 workmen in peacetime.

Pan American Airways Corp. received $900,000 of its 1943 revenue from hotel and restaurant operation, Pres. J. T. Trippe told stockholders at the annual meeting recently, while $700,000 came from avigation school activities and $450,000 from the sale of radio equipment to the Armed Forces.

Murray Corp. of America has arranged a $25,000,000 VT credit with several banks to finance airframe assemblies for the Boeing "Superfortress", Consolidated "Liberator", and Republic "Thunderbolt".

Aviation Corp. reports net profits for the six months ended May 31 of $2,317,853 or 40c. a share against $1,902,163 or 33c. in the like 1943 period. Sales were $33,902,000 compared with $37,780,000 a year ago. The report does not include undistributed earnings of associated companies, including Consolidated Vultee, New York Shipbuilding, and American Central Mfg. Co.

TACA Airways stock purchased last year by *Time* magazine, involving about 20,000 shares, has been sold, at least in part, to associates of the duPont family, according to a Wall Street report. The magazine is also understood to have disposed of its holdings in Pan American Airways.

National Aviation Corp. increased its holdings of airline stocks from 24 to 31 percent of its investment portfolio in the six months ended June 30. Aircraft and accessory holdings declined slightly. Net assets per share on June 30 were $17.16 against $15.82 at the close of 1943 and $15.11 a year ago.

Thompson Products sales for the six months ended June 30 were $68,411,000 as against $64,064,000 a year ago. Volume of the Thompson Aircraft Products Co. totaled $27,460,000 compared with $24,887,000 last year. Net earnings were $1,546,030 or $4.78 a share against $1,408,152 or $4.53 a share in the same period a year ago.

Transcontinental & Western Air reports net earnings of $660,995 or 68c. a share in the quarter ended June 30, against $419,341 or 43c. a share in the like 1943 period. Operating revenues were $6,041,663, up 21 percent from a year ago.

Dividends: Braniff Airways paid a 15c. common dividend on Aug. 25 . . . Solar Aircraft made a similar disbursement Aug. 15 . . . Cessna Aircraft paid 40c. a share on Aug. 10.

Air Investors reports net assets per common share were $3.39 on June 30 against $3.10 on the like 1943 date.

ADDING IT UP.....By RAY HOADLEY

Tax outlook. The first corporate tax reduction in 15 yr. may come next year. Congressional tax experts believe that with the fall of Germany some modification in present high taxes can be made as an aid to reconversion. The cut probably will come in the normal and surtax rates, leaving the excess profits tax intact. The renegotiation legislation expires this year-end, but President Roosevelt is permitted to extend it for a six month period if he deems such action necessary. Trade officials expect that he will extend renegotiation for the first six months of 1945 at the request of the government contracting agencies.

Merger rumors. Wall Street is getting reports that a merger involving Northeast Airlines and National Airlines is in the wind. Northeast, it will be recalled recently received a franchise to operate between Boston and New York, while National is authorized to establish a route between New York and Florida. Such a combination, if it materializes, would mean provision of a line running the length of the East Coast in competition with Eastern Air Lines.

Fair prices. Defense Plant Corp., it is learned, has nearly completed its survey of disposition and reconversion possibilities for government-owned war plants. While no set formula has been applied to the sales price, determining factors will be the cost of reconstructing the plant at present prices, the cost of adaptation to civilian output, and the outlook for special wartime installations which have no peacetime value. The RFC is willing to furnish financing for the sale of DPC plants and in some cases might continue the wartime leasing program to aid in putting plants in early civilian production.

Working capital. The SEC gave the public a misleading picture of industry in general and the aircraft industry in particular when it recently released a study indicating that all industry has plenty of working capital to convert to peacetime operations without financial aid. By lumping together the well-heeled automobile, steel, railroad, and other big industries, with the aircraft and other less fortunate groups, the commission arrived at an average working picture that misrepresented the true financial condition of any given industry.

Fancy figgerin'. SEC figures showed that the companies involved did not have quite enough cash and government bonds to meet taxes, notes, advances, and accounts payable. It seems that all that abundant working capital discovered by the SEC was made up of inventories and receivables, items that are not worth their full given value even in normal times. It does seem passing strange that corporations would be taking out billions of dollars of government-guaranteed loans if their treasuries were bulging with so much working capital.

Partial payments. New War Department regulations lay down the policy that partial payments will be preferred to V, VT or T loans as a means of interim financing. At the same time the Army agrees that for contractors having numerous contracts with several agencies the loan type of financing is the most practical method for initially financing the borrower's total termination claims on an over-all basis.

(Continued from page 215)

Illinois as a laboratory and center for aeronautical activity. It is expected to be open for wartime uses early in fall and open for commercial and civilian flying after war.

Aero Insurance Underwriters, New York City, has published "A Guide to Members of Flying Clubs", available on request.

Polytechnic Institute, Brooklyn, has authorized studies leading to the doctorate in aeronautical engineering.

Curtiss-Wright Tech., Glendale, Calif., has opened a special devices division to construct Mobile Training Units for AAF-TTC.

CAA flight tests are now recorded by electric device and special moving picture camera, giving accurate record of student pilot's actions.

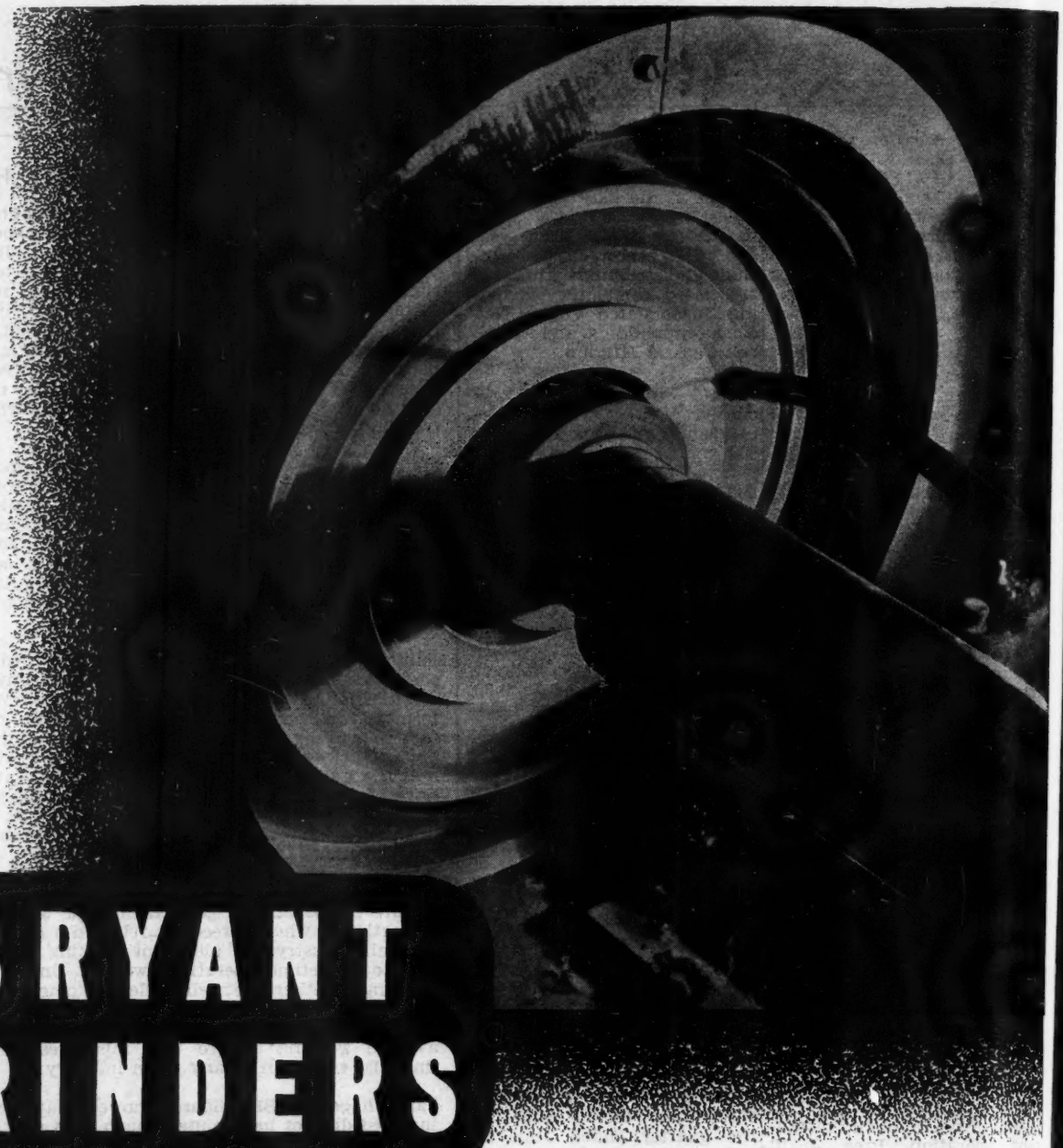
A procedure manual for aircraft radio-telephone communication is offered without charge to all CAP members by Electronic Specialty Co., Los Angeles.

First Fighter Command has given CAP permission to use formerly restricted Congressional Airport, Rockville, Md., employing northbound corridor for access.

Station operation and traffic control training for 147 Latin American youths has been launched by CAA at Purdue U. in Indiana, Tulsa, Okla., and Kansas City, Mo.

AAF Headquarters has established Missing Aircraft Service under CAP. Duties will be seeking of lost planes.

All factory training of AAF mechanics to service "Liberators", with exception of certain types of accessories instruction, is now being handled by Ford Airplane School at Willow Run.



BRYANT GRINDERS

Of all the machine tools in use by industry, none is more basic or more vital than the internal grinding machine.

Machine tool engineers have helped the men of government and of industry to plan the most desperate and gigantic production program of all time... and they can help those same men in planning today for the peace that must be won after the war is won!

One of these is a Bryant man. Send for him today!

BRYANT CHUCKING GRINDER CO.
SPRINGFIELD, VERMONT, U. S. A.

Swedes Make Airliners Out of Downed B-17's

. . . Britons warned of bigger robots with greater range

Having no suitable plane manufacturing facilities, other than those for production of small military craft the Swedes are reported to have taken several Boeing "Flying Fortresses," forced down after raids on Germany, and converted them into passenger craft. First of these ships has gone into service with the ABA on one of the regular Swedish domestic routes.

Details regarding the process of conversion employed by the Swedes have not yet come through. It is evident, however, that a "Fortress" stripped of its military equipment would offer facility for a sizable payload. And the craft's excellent range and cruising speed offer distinct advantages.

Warn of Bigger Robots With Greater Range

While recent Allied measures against the Nazis' V-1 robot bombs appeared to be having some success, official sources in England warned that reports of much larger flying bombs should be taken seriously. Word has it that German V-2 missiles caused considerable devastation when tried out in Poland.

German propaganda insists the Reich is readying not only 10-ton robots with a range to cover all England but also a special reaction-driven bomb which could reach the U. S.

While the last piece of news is taken with a grain of salt, there is no discounting the long experience of the Germans in catapulting planes from ships in the Atlantic. From such vessels, the Nazis conceivably could fire robots into American East Coast war centers.

Other developments by the Germans include use of a larger model V-1 bomb containing some 4,000 lb. of high explosives, also employment of missiles fitted with incendiaries is noted.

This Magazine—

weighs nearly two pounds. Two pounds of paper, salvaged, will make:

2 fin-locknut protectors for a bomb
22 cartons for 15 .50-cal. shells
42 cartons for 15 .45-cal. bullets
4 containers for blood plasma
4 containers for field rations
30 boxes for emergency lifeboat rations
42 cartons for life-preserver lights
58 cartons for lifeboat-inflating cartridges
14 cartons for Army K rations, or
22 cartons for yellow-fever vaccine

There is no such thing as "waste" paper today—save every scrap to win the big scrap. Paper saved today fights for you tomorrow!

★INTERNATIONAL BRIEFS★

In Switzerland, first test flights have been made on the "Pilatus," 5,000-lb. feeder plane with 450-hp. "Wasp" engine. Plane has low wing and power loading to make takeoffs from small mountain airfields practicable.

Civilian airmail from England to Spain, Portugal, Switzerland, and most of North Africa was recently resumed.

The French, before the recent Allied push, were reported building a new "super" cargo plane for the Germans, indentified as the ZS-523. Termed a modification of the Me-323 this design called for a gross weight of 90 tons, six partially retractable wheels, and six engines rated at 1,500 hp.

A French Hispano Suiza multiple engine drive was recently adapted to the Heinkel He-177 and its commercial counterpart, the He-274. With two 1,200 hp. engines at a small angle, gear box incorporating free-wheeling device drives two four-bladed constant speed contra-rotating propellers.

Word on new Hawker "Tempest" reveals that it mounts a 2,200-hp. Napier "Sabre" engine, giving top speed well over 400 mph.

Germany's new rocket firing interceptor is designated the Me-210R.

Reports state Germany is now using a reversible pitch prop. of Swiss make on the Me-109F.

Latest English planes being equipped with four-bladed propellers are the "Typhoon" and the "Halifax" glider-tug.

Japs are now flying the Aichi O2, two-seat reconnaissance bomber generally known as the "Judy". Power is supplied by inverted in-line engine of German type.

Dowty of England recently announced that weight of its new undercarriage for "Lancaster" bomber (minus wheels) is but 1.63 percent of plane's gross weight.

Two airlines now operate in Iceland—the Flugfelag and Loftleider companies. Former has been in service more than eight years; latter, currently flying a single plane, was started three months ago by U. S.-trained Icelanders.

American flyers recently reported sighting first operational models of Messerschmitt "Swallow" jet-propelled fighters.

Latest novelty of Nazis is a Mayo-composite-type combination craft consisting of a Ju-88 with a Me-109 riding piggyback. Me-109 is stated to have control for both planes, with Ju-88 underneath employed as enormous flying torpedo. Combination is said to be slow, and hence a "sitting duck" for Allied fighter pilots.

German Heinkel 177, four-engined twin-propeller bomber, is said to carry 12,300 lb. of bombs and to scale 68,000 lb. in gross weight. Top speed is put at 285 mph. at 20,000 ft.

Lord Beaverbrook states that the new "Shetland" flying boat should be flying any day now.

The British Government has become sole owner of Power Jets, Ltd., which developed Whittle's jet engine. Action stems from contention that engine is of sufficient importance to warrant development with full government backing.

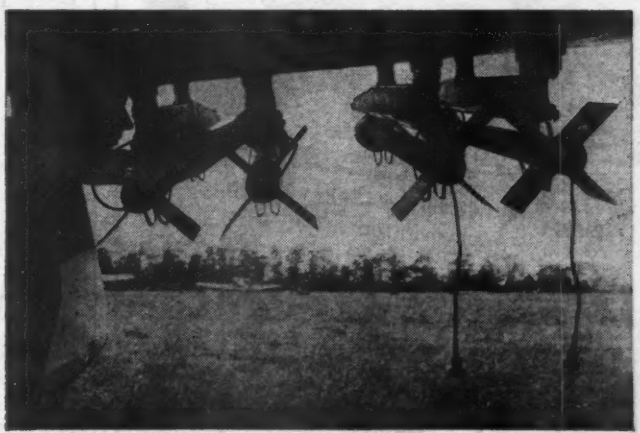
WORLDATA . . . . . By "VISTA"

On the heels of CAB's mapping of a "favored" system for postwar international routes, which showed Spain as one of the main crossing points for lines to Southern Europe and the Near East, came a State Department report that an agreement had been reached with Spain for landing rights in that country. Details await return of the official mission which went to Madrid; accordingly it has not yet been divulged whether there are any reciprocity agreements or limitations. It is a hopeful sign, however, that steps are being taken to assure start of civil international service immediately at the war's end without having to wait for endless conferences and horse-trading regarding the right of U. S. planes to land.

Additional news on the plans of the new Swedish international airlines is now available: Apparently the program is not limited to the already publicized Sweden-U. S. line. Other proposed routes will, in effect, constitute a Scandinavian *bloc*, with Danish and Norwegian as well as Swedish interests. Service to Buenos Aires and Rio de Janeiro is proposed.

Reports from the Bahamas indicate that another company will soon enter the fold of the many Pan American subsidiaries. Preliminary purchase by PAA of a minority interest in Bahamas Airways, Ltd., was recently announced, with plans to establish connections between the major islands of the group.

London's postwar Starnes Airport previously mentioned in AVIATION, is situated close to the Great West Road, one of England's main traffic arteries, and it will also be connected with London by extension of the Underground. Work at present mainly consists of installation of the drainage system. The main runway, it is stated, will have a length of approximately 3½ miles.



PLUGGING IN THE "SWOOSH" MISSILES

Under-wing installation of rockets on Britain's Hawker "Typhoon" features simple clip-on fittings. Armorer is seen engaging electric plugs by which projectiles are fired. Note that missiles resemble elongated potato mashers and employ ordinary square-design vanes. (British Combine photo.)

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Strictly an air transportation magazine . . .

Devoted wholly and exclusively to serving the specialized needs of the air carrier and allied interests concerned with the progress of air transportation. Each month an adequate, seasoned editorial staff appraises and presents the significant trends and developments of America's swiftest-growing public carrier. In its first year, *Air Transport* has become the strong national voice of the industry.

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Air Transport, with *Aviation* and *Aviation News*, completes an intensive, adequate coverage of all aviation interests. *Aviation* (America's oldest) serves the basic needs for administrative, technical and business information. *Aviation News* presents swift, weekly interpretation of all the significant aeronautical news developments.

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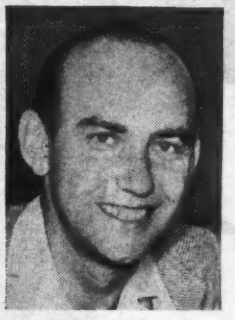
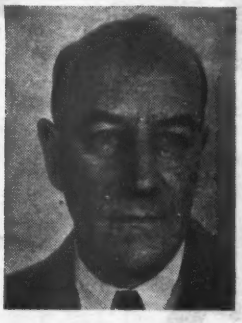
Aviation People

COL. NELSON S. TALBOTT has been named Supervisor of Midcentral Procurement District, AAF, succeeding Col. John G. Salsman, who has received an overseas assignment. A World War I veteran, Col. Talbott recently has been AAF representative at Hummer Mfg. Co. (AAF Materiel Command photo.)



ROBERT F. McKEE has joined Continental Air Lines as maintenance engineer, where he will have full responsibility for all drafting, weight and balance control, repair and alteration changes, and forms and engineering reports. A native of New Mexico, McKee was formerly with TWA as airways engineer.



ROBERT L. KINCAID, formerly assistant to Chief of CAA Airway Traffic Control Branch has been named Assistant Manager in charge of Operations at Washington National Airport, succeeding Earl Steinhauer, who has joined Fairchild at Hagerstown. Kincaid joined CAA in '37 after 10 yr. as Syracuse airport manager.

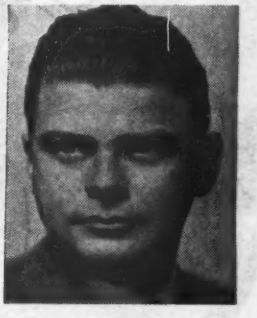
EDMUND C. SULZMAN, formerly chief field engineer for Wright Aeronautical Corp., has been made manager of sales division of engine company. A native of Newark, N. J., he is a graduate of Cornell. He joined Wright company in 1934 as a field engineer doing test and installation work.

CHARLES H. GALE, veteran aviation writer and one-time assistant editor of Aviation who recently has been with Hill & Knowlton, has established his own public relations firm at 515 Madison Ave., New York City. Firm will offer general industrial public relations counsel and research and editorial services.

MRS. THELMA SWANK OSTROW has been named Director of Counseling for Convair, heading women's counseling activities for company's 13 divisions. Prior to joining Convair in 1942, Mrs. Ostrow served 8 yr. with Oklahoma City U. S. Employment Service.

DON V. SEEVERS has resigned his position with All American Aviation, to become Executive Director of newly formed Feeder Airlines Association. Seevers' new duties take him to Washington, D. C., where he will have offices at headquarters of new association.

JOHN B. WALKER, Assistant to the v.-p., United Air Lines, has been elected vice president in charge of sales for Aircraft Accessories Corp, to direct current and postwar sales, including newly developed electronic communications equipment.

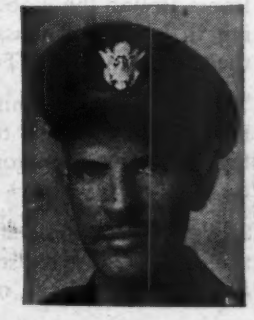


CHARLES J. HODGE has become director of industrial relations of Republic Aviation Corp. at Farmingdale, being transferred from personnel relations manager at Republic's Evansville, Ind., plant. Prior to joining Republic he was in Personnel, Office of Secretary of War.

GEORGE J. NEWMAN, former Convair division manager at Ft. Worth, has been elected v.-p. in charge of production for Globe Aircraft Corp. At 36, Newman has had 20 yr. experience in aviation, and he has worked in every phase of production.

LEONARD C. MALLETT (left) has been elected General Manager of Pratt & Whitney Aircraft Corp. of Mo., succeeding **FREDERICK C. DAWSON,** (center) who has gone to United's Sikorsky Div. in Bridgeport. Mr. Mallett joined United in 1929 as accountant in charge of Cost Department of Sikorsky. Formerly he had been with Fairchild and General Airplanes Corp. **RONALD T. RILEY** (right), v-p. and a director of Canadian Pratt & Whitney Aircraft Co., has been appointed Assistant General Manager of P & W's Missouri company. He came to United in 1937 and, after a year's intensive installation, operation, and maintenance training, went to Montreal to become Assistant to President of Canadian subsidiary. Early in 1941 he was named secretary-treasurer and director of Canadian P & W and a director of Canadian Propellers, Ltd., formed to produce Hamilton Standard propellers in Canada. (Mallett photo by Bachrach; Riley photo by Notman.)

MAJ. CLAYTON E. JOYCE, UAL pilot on military leave, has been appointed to newly-created position of chief pilot of Air Transport Command's India-China Wing. His duties include responsibility for flight crew distribution, flight procedures, transition training, and also location of avigation aids. (UAL photo.)



COLONEL FRANKLIN C. WOLFE, chief of AAF Materiel Command's armament laboratory, who has been relieved of duty pending retirement because of physical disability. A world famed aerial armament expert, he supervised 75-mm. installation and also devised B-29 armament. (AAF Materiel Command photo.)

REHEARSING FOR THE AIR-LANES OF TOMORROW

In Europe, in Asia, in the South Pacific . . . on battle fronts around the globe . . . American pilots are fighting to Victory. Thousands of these air heroes won their wings in Ryan PT-22's . . . at Ryan flying schools.

To get these superb military pilots started right, Ryan has been privileged to conduct a most extensive flight-training operation for the United States Army for nearly five years.

Daily, Ryan Schools at Hemet, California, and Tucson, Arizona, fly a distance equal to *five trips around the world.* Hundreds of seasoned pilots, men and women skilled in maintenance, and technical experts make the Ryan Schools a smooth-functioning organization experienced in the operational problems which must daily be met to keep such a large-scale project operating at peak efficiency.

Ryan Schools, with more than 20 years of active flying experience, are also, in effect, operating laboratories for the aircraft designers of the Ryan Aeronautical Company; they are instrumental in bringing new and improved methods to flying operations and better ideas on streamlined maintenance.

FIRST IN THE U. S.—Ryan, in 1925, established the first year 'round passenger air-line in the United States. The next year this pioneer organization began manufacture of planes for the air-mail service and pioneered in establishing the important Pacific Coast airway from San Diego to Seattle.

RYAN

RELY ON RYAN TO BUILD WELL

RYAN SCHOOL OF AERONAUTICS, SAN DIEGO, CALIFORNIA
OPERATING BASES: HEMET, CALIFORNIA, AND TUCSON, ARIZONA
THE RYAN SCHOOLS ARE SUBSIDIARIES OF THE RYAN AERONAUTICAL COMPANY

Side Slips

THE WIMMIN, bless 'em, seem to remain wimmin no matter what uniform you put on them or what work they do. Other day at a Marine Air Station, for example, we came up behind a group of service females waiting for a bus. Dressed in those non-Lilly Dache fatigue hats, no-sex-appeal coats, and baggy britches, they all looked just like a bunch of GI's. But, as our bus swung around the group, one gal really stood out in bold feminine relief despite all that. For she was gazing rapturously into a big bunch of flowers clutched in her grimy fist, each flower as feminine as she herself was good looking—which was plenty.

• But don't think the ladies aren't holding their own around that base; they do everything from maintaining planes to working in the control tower. The latter job caused one hot fighter pilot more than a little embarrassment. As a feminine voice answered his call to the control tower the first time, he just couldn't resist a wise crack.

• When called on the carpet his denial got him no place fast. Seems they make recordings of all radio contacts with planes, and they played his conversation right back at him. Good old grapevine soon did its work, hence the boys now talk strictly business.

• Having cut our air transportation teeth on planes that literally bulged at the seams with ten passengers, we get quite a boot out of some of today's casually-accepted cargo and passenger luggers. Their roominess was brought home forcibly the other day when we were making a trip in a Curtiss C-46 *Commando*. Besides the crew of three, there were 26 passengers aboard, among whom was an amateur—but good—magician who finally exhausted his repertoir of slight of hand tricks, but not his energy. Spying a couple of lengths of cargo tie-down rope he went to work, for there was still room for him to do cowboy rope tricks. No one got clipped; the pilot didn't even feel it as the A.M. jumped in and out of whirling loops.

• This same magician-rope twirler would undoubtedly have been a handy man to have around in Burma recently, when some RAAF men loaded cows into Douglas C-47's to ship them in as supplies for an advanced base accessible only by air. But even he might have been thrown for a loss, for each of the white cattle had first been dyed a "mousy mauve" for camouflage purposes, and that's too much to ask even a magician to lassoo.

• The lads flying stuff over the hump to China never seem to think a plane is not airworthy unless it just won't get off the ground. For instance, there was the laconic "minor accident" report one sent in —after completing his flight. It read simply: "Plane swerved on cross-wind takeoff, pilot regained control, continued flight. Hit three native laborers, one tree top. Minor damage to wing."

• The way the surplus light planes are going at those oh-so-high ceiling prices, it seems some of the pessimists will have to raise their sights on postwar markets. We certainly hope so. But we hope just as fervently that the prices will quit banging their heads on the ceiling.

• Overloaded airplanes are just run-of-the-mill these days, but sometimes those things can be carried just too far. There was, for instance, the faithful old DC-3 which was rolled into the shop for a complete overhaul and refurbishing, including a weight check. Up on the scales it showed 1,700 lb. too much, for no apparent reason. The scales were checked, but still she was 1,700 lb. too heavy. Finally, in desperation, the crew ripped up the floor boards—where they found 17 sandbags weighing 100 lb. each. Put in to maintain balance while the ship was stripped, they'd since been completely forgotten.

• This one goes back to World War I, before most of today's Air Force was born: Frenchman was telling of a friend of his, "a marvelous warrior, but a terrible soldier; he was always getting himself in jail." Once, on the third day of a 14-day sentence, this friend was hastily summoned from his durance vile, driven by special car back to his squadron, briefed, and sent out with 24 other bombers on a particularly tough mission. His was one of three planes to return, but as soon as he'd landed, right back in the clink he went. Two days later he was again hauled out, driven to his base, and decorated with a rare and hard-to-get medal —then for a second time, right back in the clink he went. But not just for the expected nine days—he stayed eleven. The days he'd been out bombing Huns and getting the medal didn't count.

"Maguire didn't wait for WPB to authorize materials for experimental models—he's ready to go now!"

KEEP POSTED ON

Products and Practices

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profit through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation.

ENGINEERING DATA

Wear Phenomena 1

D. Landau, industrial applications engineer of Nitralloy Corp., New York has written booklet, *Wear, A Discussion of the Mechanism of Wear Phenomena and Influencing Factors,* covering such subjects as: molecular adhesion, surface melting, lubricants and wear, scoring, gear pitting, chemical effects, and surface finish and wear. Charts and examples are given.

Conveyor Case Histories.....2

Lamson Corp., Syracuse, offers booklet *Case Histories to Aid You in Blueprinting to Peace* which describes conveying problems, their solutions, and postwar applications.

Wire windup Machine.....3

Constant-speed, constant-tension windup machine for wire, cable, rubber, tapes, and fabrics is described in folder offered by Industrial Oven Eng. Co., Cleveland.

Radial Engine Cooling.....4

Newsletter on cooling fan for radial engines is offered by Rotol, Ltd., London, Eng. Special type of cooling fan driven at propeller speed by propeller spinner is described.

Spray Painting Pointers.....5

Westinghouse Elec. & Mfg. Co., E. Pittsburgh, offers bulletin *Spray Painting Pointers for Industrial Engineers* covering objectives in spray painting, preparation of material, rate of flow, atomization adjustment, gun stroking, selection of feeds, and other subjects.

Small-Spring Handbook 6

Fundamental data, tables, and information concerning small springs is given in technical handbook published by Accurate Spring Mfg. Co., Chicago.

Electronic Products 7

Booklet offered by North American Phillips Co., New York, describes its organization, products and affiliations, part in the war effort, and future plans.

Wire Products 8

Let's Take a Tour With Wic and Spen, the Wire Men, is booklet offered by Wickwire Spencer Steel Co., New York, concerning company's products and how and by whom they are used.

Molded Plastics 9

Details of fabricating laminated plastics and vulcanized fiber are covered in booklet published by Continental-Diamond Fibre Co. Newark, Del. Instructions in best methods of shearing and sawing, punching, machining, milling, drilling, reaming, etc., are given.

Synthetic Resins 10

Information is available on "Silicones", new organo-silicon polymers, product of Dow Corning Corp., Midland, Mich.

Aircraft Catalog 11

Aircraft catalog and handbook covering AN fittings, AAF 811 fittings, hose-and-hose assemblies, valves and hydraulic cylinders, and compilation of engineering data, is offered by Weatherhead Co., Cleveland.

Bearing Lubrication 12

Typical applications of Farval Dualine system of lubricating high-up and hard-to-get-at bearings on off-the-floor equipment are shown in booklet *Aloft is No place for AWOL (Absent Without Lubrication) Bearings.* "Publisher is Farval Corp., Cleveland.

Label Ideas 13

Tools of Business, catalog offered by Ever Ready Label Co., New York, features stock labels for industrial use and considers applications and economies.

Electronic Items Available.....14

Industrial availability booklet, published monthly by Walker-Jimieson, Chicago, lists electronic items available on priority for stock delivery.

Die Handling Trucks.....15

Die Handling Made Easy is bulletin describing hydraulic die handling trucks made by Lyon-Raymond Corp., New York. Types, sizes, specifications, and applications are shown.

Hose Clamp 16

"Punch-lok" method of banding, clamping, or splicing hose is described in bulletin from Punch-Lok Co., Chicago. Tools, materials, and methods are shown.

Rivet Catalog 17

Applications of "Rivnut" blind fasteners made by B. F. Goodrich Co., Akron, are described in new catalog section just published by company.

Adhesive Problems 18

Aid in selecting proper adhesives for specific jobs is offered in data sheet and questionnaire offered by Paisley Products, Chicago. Details of fabricating and packaging adhesive problems are studied and solutions given.

Sealing Compound 19

Information is available on "Galco" new sealing compound developed for sealing aircraft integral fuel tanks. Material manufactured by Prestite Engineering Co., St. Louis, is a Thickol synthetic rubber compound of latex type, designed for spray brush, or slush applications.

Castings Salvage 20

Aluminum, bronze, gray iron, malleable, and steel castings may, it is reported, now be salvaged by new Mogul nervous weld process developed by Metallizing Co. of America, Chicago. Process is described in bulletin.

Self Tapping Screw.....21

Users' Guide, offered by Parker-Kalon Co., New York, contains engineering and production data on application of self tapping screws.

Aluminum Welding 22

July 1944 issue of Oxy-Acetylene Tips, house organ of Linde Air Products Co., New York, contains brief discussion of fundamental principles for welding aluminum sheets, plates, and castings.

MACHINERY & ACCESSORIES

Hydraulic Gear Pumps.....23

Serving as prime movers for hydraulically operated machines, drives for smaller auxiliary units, pilot pumps to generate pressure for operation of large hydraulic valves, and for other purposes, are hydro-power gear pumps made by Hydraulic Press Mfg. Co., Mt. Gilead Ohio. They are described in *Bulletin 440,* just issued by company.

Repair Equipment 24

Wolfe & Mann, Baltimore, announces new catalog on many types of aircraft repair equipment, including work stands, jacks, stands, trailers, and dollies.

AVIATION READER'S SERVICE

AVIATION, 330 W. 42nd St., New York City

SEPTEMBER 1944

Please send me additional information according to key numbers circled.

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31	32	33	34	35	36	37	38	39	40	41	42	43					
NEW PRODUCTS					44	45	46	47	48	49	50	51	52	53	54	55	56	57
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Sawing Machine 25

Bulletin from Continental Machines, Minneapolis, Minn., describes new "Doall Zephyr", high speed friction sawing machine, and gives specifications and applications.

Pneumatic Vise 26

"Airlox" pneumatic vise having sides as well as base key-wayed, so that it can be mounted either way, is described in bulletin from Production Devices, New York.

Short-Run Turning 27

Nine different solutions to special lathe or high production jobs, such as turning and grooving aircraft pistons and taper turning valve plugs, are shown in booklet *How to Increase Production On Short-Run Turning With an Automatic Lathe.* Publisher is Sundstrand Machine Tool Co., Rockford, Ill.

Piston Ring Lapper.....28

Designed for operation by engine mechanics in field or base overhaul shop, Fulmer piston ring lapper is described in bulletin from C. Allen Fulmer Co., Cincinnati.

Contact Grinding Rolls.....29

Stated to meet all requirements of abrasive belt grinding, "Compress" contact rolls, made by Divine Bro. Co., Utica, N. Y., are described in bulletin.

Gage Blocks 30

The Saga of Ellstrom, booklet from Dearborn Gage Block Co., Dearborn, Mich., is story of development of original gage block by Hjalmar Ellstrom in Sweden.

Electronic Weld Timer.....31

New combination timer-contact package unit, designed to provide automatic electronic control for resistance welders, is detailed in *Technical Bulletin No. WTTC-44* from Weltronic Co., Detroit.

Hydraulic Jacks 32

Hydraulic jacks for aircraft are described in catalog from Malabar Machine Co., Los Angeles. Material includes specifications, description of weight indicators for cargo loading, and manual on maintenance.

Plating Equipment 33

Plating and buffing equipment is described and methods and applications suggested, in booklet from Frederick B. Stevens, Detroit.

Welding Positioners 34

Model WP-2, new welding positioner, is topic of bulletin from Harnischfeger Corp., Milwaukee. Description, specifications, and uses are given.

Rotary Files 35

Catalog from Rotary File Co., Stratford, Conn., gives data on development of hand-cut rotary files.

ELECTRICAL

Connector Wall Chart.....36

Designed for use in aviation schools, plants, depots, fields, and repair shops, Type K chart from Cannon Electrical Development Co., Los Angeles, gives data on K connectors.

Thermal Control Catalog.....37

Fenwal, Inc., Ashland, Mass., offers new catalog describing "Thermoswitch" and other products. Given are installation drawings and photos for temperature and pressure control apparatus.

Position Welding 38

Information on welding positioning equipment and processes is described in *Bulletin No. 2106* from Ransome Machinery Co., Dunnellen, N. J.

Heat & Airflow Measurement.....39

Instruments for measurement of engine temperatures and air velocities are described in bulletin from The Revere Co., Wallingford, Conn.

Welding Voltage Regulator.....40

Information is available on new voltage regulator for use with resistance welding controls that incorporate phase-shift method of heat control. Regulator is made by General Electric Co., Schenectady.

Resistor Catalog 41

Specifications and engineering data on "Koolohm" wire-wound resistors made by Sprague Electric Co., North Adams, Mass., are given in new company catalog.

STEELS AND PLASTICS

Shape Cast Steels.....42

Cast-to-shape steel parts made by Jessop Steel Co., Washington, Pa., is topic of new company booklet. Contained are photos of special parts and offered are heat-treating hints for maintenance of tools.

MANAGEMENT & EMPLOYEES

Care of Valves.....43

For instruction of employees, Reading-Pratt & Cady div., American Chain & Cable Co., Bridgeport, Conn., offers *Do's and Dont's* chart containing eleven tips on handling and care of valves.

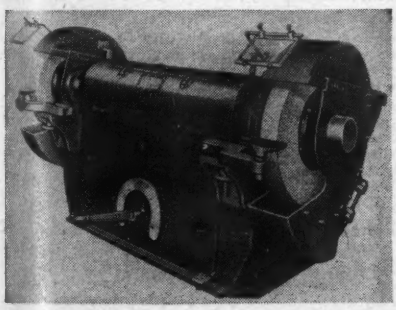
Erratum: Item 88 in the New Products department of July AVIATION ("Bracket for Switches," page 246) erroneously gave the address of the manufacturer, Micro Switch Corp., as Rockford, Ill. Correct address is Freeport, Ill.

NEW PRODUCTS

Latest Machine Tools

Multi-Speed Snagging Grinder.....44

Available in 30 and 40 hp. Model 69 gear-driven multi-speed snagging grinder, built by **U. S. Electric Tool Co.**, Cincinnati, is powered by totally enclosed



fan cooled motor. Variable speed enables maintenance of peripheral speed.—**AVIATION, Sept., '44.**

Laboratory Press 45

New laboratory press, total capacity, 20 tons, and stroke of 5 in., is announced by **Anderson Bros. Mfg. Co.**, Rockford, Ill. Powered by hydraulic hand pump, press is designed for production straightening jobs.—**AVIATION, Sept., '44.**

Forming Roll 46

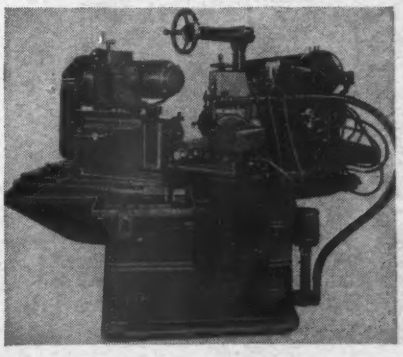
New model for forming leading edge or fuselage skins automatically in one pass is announced by **Paragon Research,** Buffalo (designer for Farnham Mfg. Co.). Movement of upper roll is controlled by two templates. As part feeds through rolls, templates raise or lower each end of upper roll as required. Hydraulic pressure keeps template followers against templates, and also raises upper roll for inserting sheet. Model is designed to form aluminum alloy sheets 1/16 in. thick, 15 ft. long, to a minimum 1¼-in. radius.—**AVIATION, Sept., '44.**

Belt Grinder 47

Bench type belt grinder made by **Porter-Cable Machine Co.**, Syracuse, uses endless metal cutting abrasive belt 2½ in. wide by 60 in. long, running 4,500 sfpm. Drive is by 1-hp. motor. Flat bed grinding area is 2½ x 8 in. and soft, resilient contact wheel is 7 in. dia. by 2½ in wide. Wheels of 6 to 8-in. dia. may be used. Arbor is 1 in.—**AVIATION, Sept., 44.'**

Race Grinder 48

Stated to be completely automatic, roller bearing race grinder made by **Fitchburg Grinding Machine Corp.**, Fitchburg, Mass., is designed to operate



through its standard cycle at push of a button. Workhead is adjustable from 0 to 75 deg. and can be arranged hydraulically or pneumatically for chucking. In taper grinding application, wheelhead is mounted on a 45 deg. slide for trueing. Trueing device is mounted parallel to wheelhead and is hydraulically operated, with micrometer adjustment.—**AVIATION, Sept., '44.**

Hydraulic Press 49

Colonial Broach Co., Detroit, offers new line of "Junior" hydraulic presses, 1, 2, and 3 ton capacity, in bench and base types. Presses are designed for assembly work and push or pull broaching. They may be converted from bench to pedestal

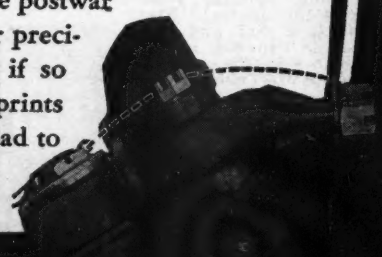
PART and PARCEL OF RADIAL *Aircraft Engines*

AIRCRAFT "Tailor Made" NUTS

Here illustrated is a Lord RS-40 Dynafocal Assembly equipped with Aircraft "Tailor Made" nuts. This assembly is a flexible mounting system acting as a radial aircraft engine support.

These flexible suspensions weigh about one percent of the total weight of the engine, yet the assemblies withstand forces produced by these engines and provide ample stability at all speeds. Aircraft nuts are an important part of this precision made assembly in that they keep the assembly tightly held together. Another case where vital aviation equipment demands the quality of Aircraft "Tailor Made" nuts because they fit properly and are truly precision built to the highest standards of craftsmanship.

Perhaps you have postwar requirements for precision made nuts, if so send us your blueprints and we will be glad to quote prices.

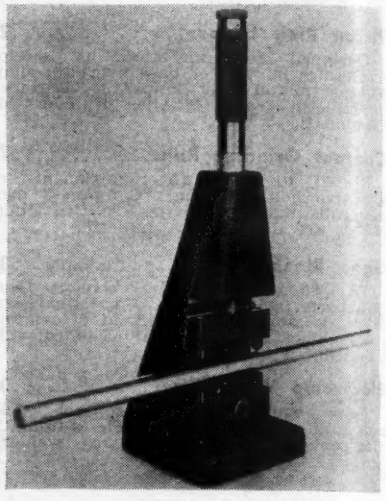


Aircraft
NUT CORPORATION
2029 E. 102nd ST. • CLEVELAND, O.

types. Platens are counterbored concentric with ram. Base below platen is slotted and relieved. Sides of slot are machined in relation to axis of ram to equalize clearance for fixtures. Motors are mounted vertically in column to furnish power for hydraulic mechanism and are designed for 50 or 60 cycles. Stroke is altered by changing position of stop collars. Normal ram speed is 30 ft. per min. Accesories include variable pressure control and pressure gage. Illustration shows 2-ton size.—**AVIATION, Sept., '44.**

Gage Point Punch.....50

Double-acting and with adjustable impact force, new gage point punch made by **Baldwin Locomotive Works,** Philadelphia, is reported to have these features: (1) It marks four uniform centers with one handle push; (2) it automatically centers either round or flat specimens; (3) impact force is applied manu-



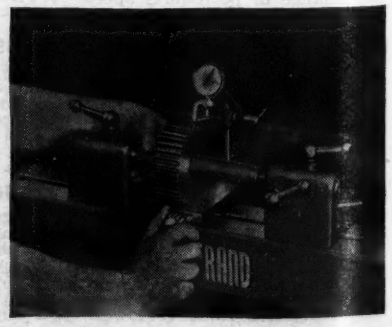
ally by an adjustable detent which eliminates use of hammer; and (4) impact and size of punch marks is adjustable for hard and soft specimens. Upper punch holder is attached to handle. Upper punch point assembly is spring supported to keep gap open full. When specimen is placed on support, upper handle is pushed down until all points touch, and continued push on handle brings to pre-adjusted compression a second spring within handle, to release potential energy to produce impact.—**AVIATION, Sept., '44.**

Slide Press 51

E. W. Bliss Co., Brooklyn, announces new 5,000-ton hydraulic two-die slide press which incorporates rubber die process. Featured is automatic cycle which causes die slide to move into position; press then completes cycle with pressure independently adjustable for each die slide, says maker. Specifications: Pad size, 50 x 144 x 12 in.; max. stroke, 40 in.; floor space, 550 x 170; height, 30½ ft.—**AVIATION, Sept., '44.**

Bench Centers 52

Precision in checking work between centers is said to be simplified and speeded by one-hand control featured in bench centers made by **Sundstrand Machine Tool Co.,** Rockford, Ill. Unclamping, positioning, and locking of LH. and RH.



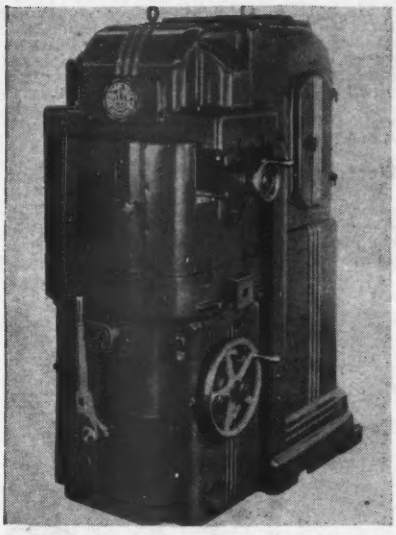
heads are achieved with one-hand operating top lever. Center in LH. head is fixed, but RH. is spring loaded and can be retracted by end bar. Front clamp on RH. head locks center in position. Indicator support is manipulated with one hand. Portable, the bench centers include bed and two heads and are available in sizes 6x18, 6x36, 12x36, 12x48, 12x60, and 12x72 in.—**AVIATION, Sept. '44.**

Polishing Lathe 53

Jones Engineering Co., Ellwood City, Pa., has developed new heavy duty polishing lathe No. 143 designed for bench or stand mounting. Employing two contact rolls equipped with endless abrasive belts, it is built for two 14 in. dia. 3-in. face contact rolls, has 1 11/16 in. dia. shaft, and is 34 in. long. Spacing between inside faces of wheels is 24 in., with 9 in. from base to center of shaft. Longer shafts are available. Unit is powered with 2, 3, or 5 hp. motor, mounted underneath.—**AVIATION, Sept., '44.**

Rotary Gear Finishers.....54

Among improvements reported for "860" series of rotary gear finishers, made by **Michigan Tool Co.,** Detroit, are use of cone-drive gearing for maximum drive-smoothness and quieter operation, ability to obtain shaved gears with superior finish, increased power for special jobs, improved facilities for curve-shaving, greater flexibility, and reduced maintenance through "one-shot" lubrication. Line comprises models for shaving narrow face and shoulder gears by underpass method, shaving wider faced gears by transverse method, model in which both methods are provided (illustrated), and model for shaving internal gears. Power has been increased to 2 hp. Improved facilities for curve shaving are available as optional equipment. Either entire tooth face may be curve-shaved

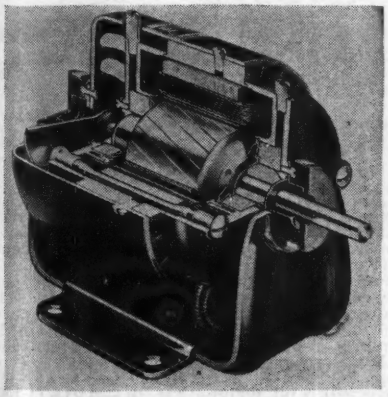


or any desired amount of center section of face left flat, relieving only one or both ends of tooth. Amount of relief at two ends can be varied by offsetting flat section in center to either side. Two sets of change gears are provided on Nos. 860, 860-B, and 860-C; one set gives five variations in speed of reciprocating mechanism. On 860-A (underpass or transverse method) there are separate provisions for change gears for each movement, but same actual gears can be used interchangeably for each. Standard equipment includes six gears each for cutter spindle and reciprocation speed changes.—**AVIATION, Sept., '44.**

Shop Equipment & Accessories

Shaded Pole Motor... 55

Designed for power requirements of 1/125 to 1/25 hp., **A. G. Redmond Co.,** Owosso, Mich., offers new shaded-pole totally enclosed motor incorporating pressure-locked rubber mounting. Mounting assembly consists of two rubber pads,



two spring steel lock rings, and base. Type "T" micromotor uses "flush-weld" rotor design. Rotor slots are copper filled flush with circumference, with preformed copper inductors, fuse welded permanently. Small size is said to be made possible by air-stream cooling system using enclosed fins and fan.—**AVIATION, Sept., '44.**

Aviation Calculator 56

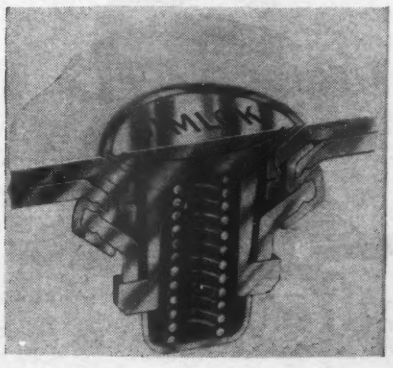
Equivalent to a straight slide rule 170 in. long, this 10¾ in. "Starmeter" dia. spiral slide rule is designed solely for solution of spherical triangles encountered in celestian avigation problems. Two scales are used: One in colored bands for multiplying and/or dividing functions of angles, and one in wide bands for combining certain results on colored bands which, interlaced with white bands, are alternately green and yellow. Numerals are in bold type. Determination of altitude can be made in 1½ min. and of azimuth, in an additional ½ min., it is said. Maker is **Spiral Slide Rule Co.,** Chicago.—**AVIATION, Sept., '44.**

Carbide Gage Blocks... 57

Tungsten carbide gage blocks are announced by **Jansson Gage Co.,** Detroit. Three all-carbide sets are available, of ten, two, and two blocks, respectively, and one set of 81 steel blocks with two .050 in. carbide wear blocks. Ten blocks carbide set ranges in size from .050 to .0509 in. in steps of .0001 in. Two smaller sets are to be used as wear blocks with steel gage blocks. One contains two .050 in. blocks, the other two .100 in. blocks.—**AVIATION, Sept., '44.**

Aircraft Fastener ... .58

New "Simlock" fastener for cowlings and panels, made by **Simmons Machine Tool Co.,** Albany, is stated to fasten or unfasten with quick quarter turn. When unfastened, stud is self ejecting. It is



"AT THE end of 5000 cycles of rubs—felt against felt and 2 rubs per cycle—the eighteen Booth felt specimens were measured for wear. Only 4 specimens showed greater than 3.4% decrease in thickness; and 5 showed less than 2.0%."—From lab. report.

Abrasion-resistance is but one of the many characteristics closely controlled in the manufacture of Booth "prescription" felts.

THE BOOTH FELT COMPANY
482 19th Street Brooklyn, N. Y.
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APPLICATION CHART AND SAMPLE KIT . . . Contains swatches of S.A.E. felt types, with specification tables. Write for it. (No sales follow-up.)

2072

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PRECISION CUT FELT PARTS

Cools the HOT SPOT!

We've engineered and built thousands of small, fractional H.P. blower motors for operating cooling fans for hot spots such as radio tubes and transformers in many types of aircraft and radio installations. Competent engineering and precision manufacturing facilities assure volume production of small motors designed to your exact performance specifications—for any job that requires compact, lusty, dependable power. Tell us your requirements

Small Motors, Inc.

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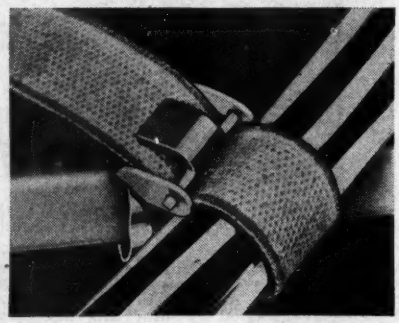
Design • Engineering • Production

made with flush, oval, and wing head, in three sizes. Hollow inner one piece housing is integral with locking lugs, and outer housing retains helical spring and inner housing as complete assembly. To lock, two sheets are brought together so stud enters receptacle, stud is depressed and turned where it locks in cam.—**AVIATION, Sept., '44.**

Electric Wire Harness.... 59

Designed to permit one-hand installation and removal of wires, simplified electric wire harness support trap has been produced by **Adel Precision Products,** Burbank, Calif. Support consists



of light-weight, synthetic sponge rubber coated fabric strap ⅝ in. wide, having a 24,800 psi. tensile strength, and a simple buckle mounting 360 deg. swivel latch. One size strap replaces all sizes of harness clips, it is said. Several types of mounting brackets are available which clamp securely to airframe structure, without holes, if desired.—**AVIATION, Sept., '44.**

Torque Wrench 60

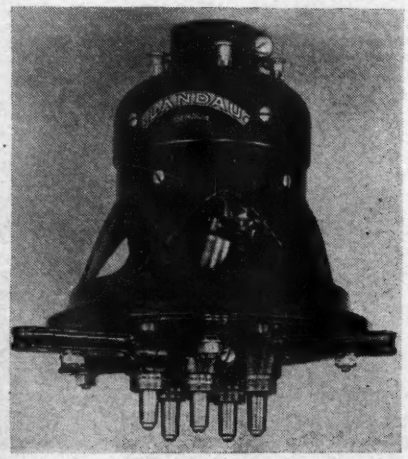
Combining right and left hand torque, new torque wrench which it is stated can't overtighten, is offered by **Aircraft Tools,** Los Angeles. Wrench is full ratchet so that when desired tension is reached, positive break-away occurs one notch at time. Torque is set in specified inch-pounds. Adjustments between 10 and 60 lb. may be made.—**AVIATION, Sept., '44.**

Aircraft Heater 61

New heater of gasoline-burning combustion type for aircraft has been developed by **Heating Div., Anchor Post Co.,** Baltimore. It is described as combining multiple functions of cabin heating in flight and on ground, defrosting windshield and bombardier's window, and preheating engines. In flight, heater is stated to have hourly output of 90,000 btu.—**AVIATION, Sept., '44.**

Multiple Drill Head.....62

Multiple, adjustable drill head, made by **Landau Machine Co.,** New York, is designed for use on any small drill press. Provided with five spindles, main drive is centrally located on mounted ball bearings and has No. 2 taper which absorbs full load capacity. Each spindle is complete unit, has double bearing, and can be set in any location by loosening one



nut. Spread of spindle is 4 in. with minimum distance ⅝ in., weight 4½ lb., and height 5 in. Spindle speeds are up to 3,000 rpm. Head is mounted on rack spindle of press and has slot and clamp screw. Opening of top head is 1¾ in., and there is split sleeve for reducing adoption hole. Feed is operated by rack and pinion. Drilling capacity is up to 3/16 in.—**AVIATION, Sept., '44.**

Aircraft Electric Actuators.....63

To retract and lower landing gear, open and close bomb bay doors, control wing flaps, and other similar functions, **Eclipse-Pioneer Div., Bendix Aviation Corp.,** Teterboro, N. J., offers electric actuators in concentric and right-angle design. Features include automatic compensating torque limiting device in form of a multiple disk clutch that is designed to protect reduction gearing, also special magnetic equalizing clutch which prevents jamming. Explosion proof motors are available in certain models. Motors are available for 24v. d c. operation.—**AVIATION, Sept., '44.**

Pivot Ball Bearings 64

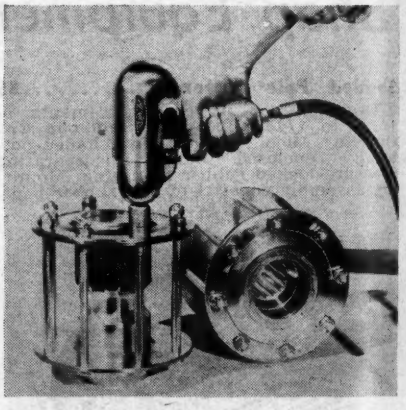
Miniature Precision Bearings, Keene, N. H., announces that pivot type ball bearings are now available in sizes from 2 to 10 mm. o.d. and made of beryllium, stainless, or chrome steel.—**AVIATION, Sept., '44.**

Plastic Preforms Heater 65

Thermex Div. of Girdler Corp., Louisville, has developed No. 2-P Thermex, plastic performs heater designed to operate at a frequency of 25 to 30 meg., using 230v., 60 cycle, single phase current Unit measures 28 x 28 x 47 in., weighs 614 lb., and is automatic.—**AVIATION, Sept., '44.**

Impact Wrench 66

Pneumatically powered and with calibrated adjusting screw controlling tension, new ⅜ in. impact wrench made by **Aro Equipment Co.,** Bryan, Ohio, is de-



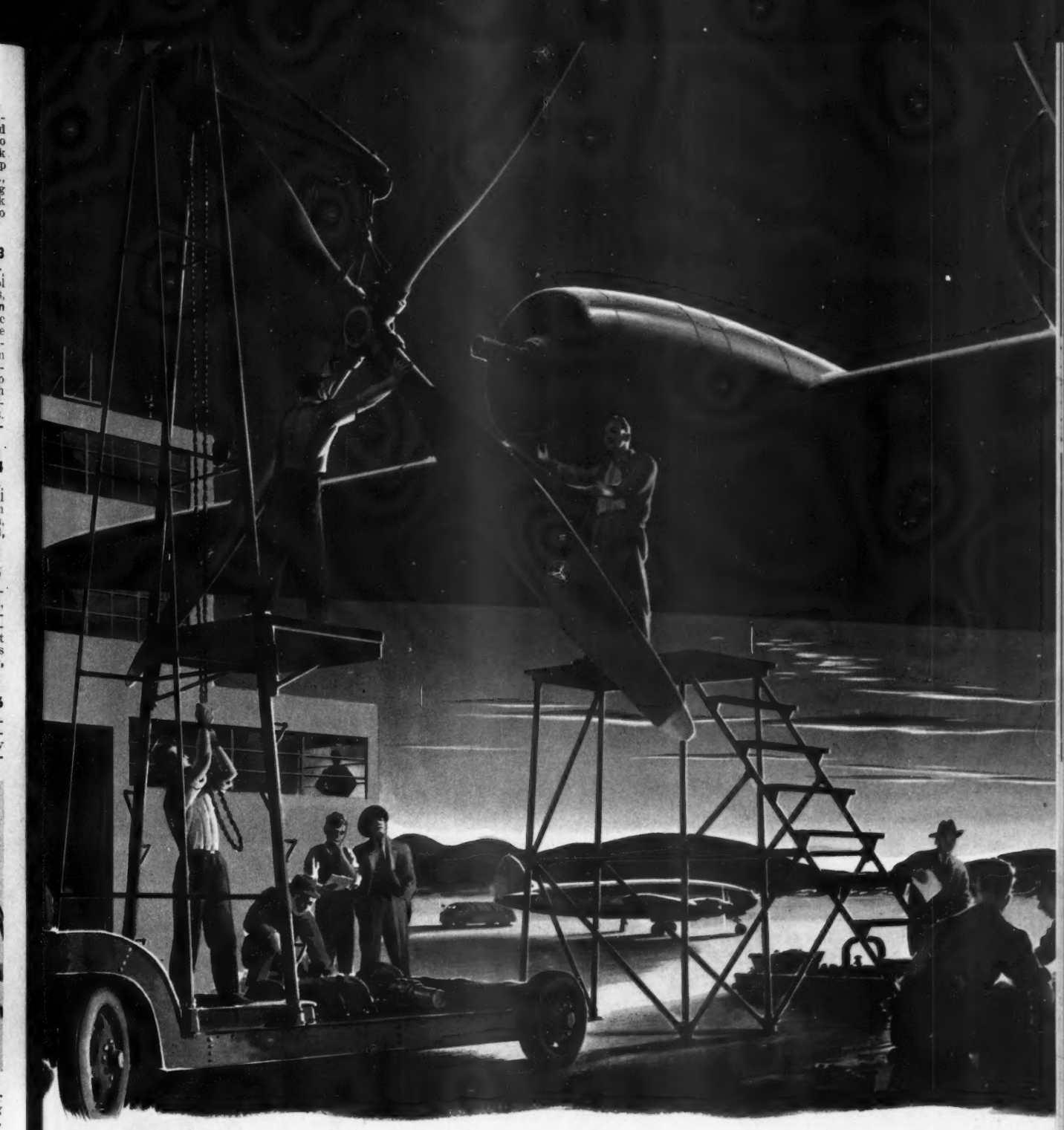
signed to be rotated either way. Roller clutch impacting mechanism, consisting of anvil, hammer, and two steel rollers, operates as control. In operation, centrifugal force throws rollers against hammer where they are caught in shear between hammer and anvil. Thus full torque is transferred to work in impact form. When selected torque is obtained, rollers rebound from anvil and do not allow hammer to engage. Model 131 has capacity up to ⅜-in. bolt size, is 6¾ in. over-all, and weighs 4¼ lb.—**AVIATION, Sept., '44.**

Welding Carbons 67

Applicable to all shapes and sizes, new "F" treatment is said to lengthen life of resistance welding or brazing carbons. Process is announced by **Stackpole Carbon Co.,** St. Marys, Pa.—**AVIATION, Sept., '44.**

Impulse-Initiated Timer.....68

Small size (3½ x 3⅝ x 3¾ in.) is feature of new impulse-initiated timer offered by **Struthers-Dunn,** Philadelphia. Named PSEH-1, it is made in d.c. and a.c. types. Contact operation occurs at end of delay interval after power is applied, or after momentary impulse from push-button, limit switch, or other source. Adjustable timing range is 20 to 1, and



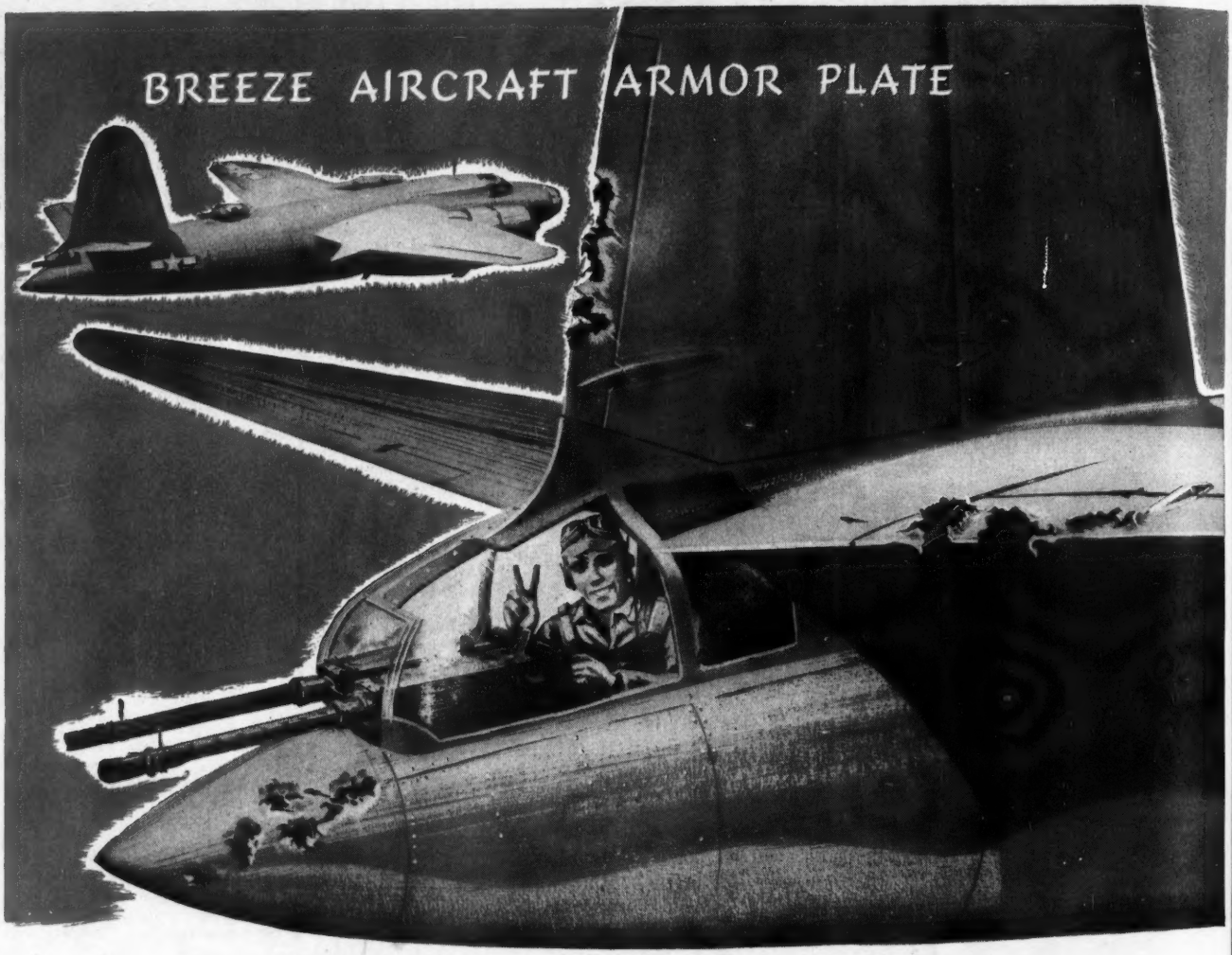
low weight *thrust* for the GIANTS

The largest propellers to fly in this country—
18 foot 2 inch four-blade hollow steel Curtiss Electrics—efficiently harness
the 3000 horsepower and more in the sub-stratosphere,
yet increase the useful load of the airplane 650 pounds through weight reduction.

All of the propeller features pioneered by Curtiss
are embodied in this installation,
including automatic synchronization, reverse thrust,
and of course, the unmatched durability of steel.

CURTISS ELECTRIC PROPELLERS

Curtiss-Wright Corporation, Propeller Division

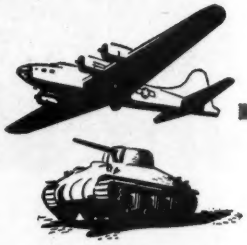


Homeward Bound

Breeze Aircraft Armor Plate Brings 'Em Back Alive In World-Wide Theatres of Warfare

Breeze Aircraft Armor Plate is in action today on Allied invasion fronts, providing dependable protection for pilots and gunners of America's hard-hitting bombers and fighters. Produced in quantity by the Breeze Electric Heat Treating Process, the fastest known for the purpose, this Armor Plate helps to bring home not only trained personnel but valuable equipment as well.

Breeze Armor is manufactured in two types: homogeneous and face-hardened. Although light in weight, it possesses the highest ballistic qualities and resistance to shatter. Complete assemblies to designers' special requirements are a specialty. Aircraft Armor Plate supplements the well-known Breeze line of equipment which is now in service on land, on the sea, and in the air.



A Few of the Many Breeze Products in the Nation's Service

Radio Ignition and Auxiliary Shielding • Multiple Circuit Electrical Connectors • Flexible Shielding Conduit and Fittings • Cartridge Engine Starters • Internal Tie Rods • Elevator and Rudder Tab Controls • Flexible Shaft and Case Assemblies • Aircraft Armor Plate

Breeze BREEZE MARK

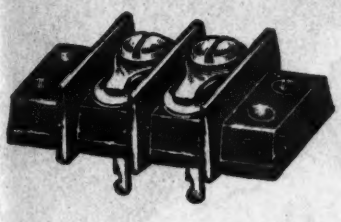
CORPORATIONS, INC. NEWARK, N. J.

PRODUCTION FOR VICTORY • PRODUCTS FOR PEACE

mechanism is immediately recycling. Built in double-pole, double-throw auxiliary relay provides variety of circuit arrangements. Timers can be supplied for a.c. operation on 110v. 60 or 25 cycles; 220v. 60 or 25 cycles; or for d.c. at any specified voltage from 6 to 120v.—AVIATION, Sept., '44.

Terminal Strip 69

Designed to permit screw connection above panel and solder connection below, new Barrier type terminal strip, developed by Howard B. Jones Co., Chi-



cago, incorporates "Y" type terminal securely mounted in block and held by screw so that connecting wire comes in direct contact with terminal. Terminal is made for No. 140, 141, and 142 series Barrier strip.—AVIATION, Sept., '44.

Gear Reduction Unit.....70

Reduced size of unit required for given hp. through use of fan cooling system, is reported for new worm gear reduction unit made by Cleveland Worm & Gear Co., Cleveland. "Speedaire" contains new type of double walled cooling system which is designed to provide air passage completely enveloping oil reservoir in which gear operates. Inner wall is deeply finned on air side and exhaust fan located on coupling end of worm shaft draws air through space from grille at opposite end, thus utilizing full heat transfer efficiency of system, it is said.—AVIATION, Sept., '44.

Carbide Milling Cutters..... 71

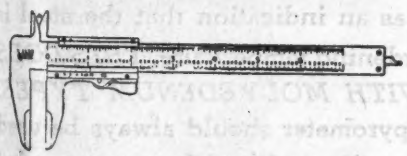
Plan-O-Mill Corp., Hazel Park, Mich., has introduced new line of carbide insert thread milling cutters available in standard and special forms, ground or unground, with straight or spiral flutes, with or without provision for Higbee cut. Both shank and shell types are offered.—AVIATION, Sept., '44.

Flush Rivet Set.....72

New flush rivet set made by Emerson Engineering Co., Los Angeles, is designed to enable operators to drive rivets with one hand while installing next rivet with other. Set includes protective rubber ring slightly higher than driving surface, which acts as guard to prevent slipping.—AVIATION, Sept., '44.

Vernier Caliper 73

Designed to meet wartime manufacturing conditions, new precision caliper made by Vard, Inc., Pasadena, Calif., is said to give quick and accurate reading of outside diameters as measured between large



jaws, and of inside diameters by reading same scale showing spread of minor inside jaws. To measure depth of hole, depth projection rod is inserted and read distance from end of rod to body of caliper on same scale. Depth gage is integral part of tool. Full 6-in. reading is possible. Vernier is integrally mounted on slide and is locked or released by thumb lever.—AVIATION, Sept., '44.

Low Pressure Gage.....74

Developed for use in aerodynamic testing and research, new low pressure gage made by Wallace & Tiernan Products, Belleville, N. J., is said to be sensitive to 1 part in 500 and accurate to 1 part in 300. Gage can be furnished to cover pressure range as low as 10 in. of water, with 330 deg. scale calibrated as desired. Gage may be had with expanded scale at lower pressures and a contracted one at higher pressures. A compound instrument measuring both vacuum and pressure is also available. Connections are provided for either ⅛-in. pipe or ¼-in. hose. Static and pressure connections permit its use as a differential gage.—AVIATION, Sept., '44.

Pin Sets 75

Precision pin sets, number drills, letter drill and fractional sizes, in compact cabinets, are being offered by United Precision Products Co., Chicago. Number drill sizes are 1 to 60, letter drill sizes A to Z (86 pins), and fractionals 1/64 to 1 in. in increments of 1/64 in. (64 pins). with tolerances made to specifications. Brass strips with white letter or number identify each gage.—AVIATION, Sept., '44.

Diamond Dresser Tool. 76

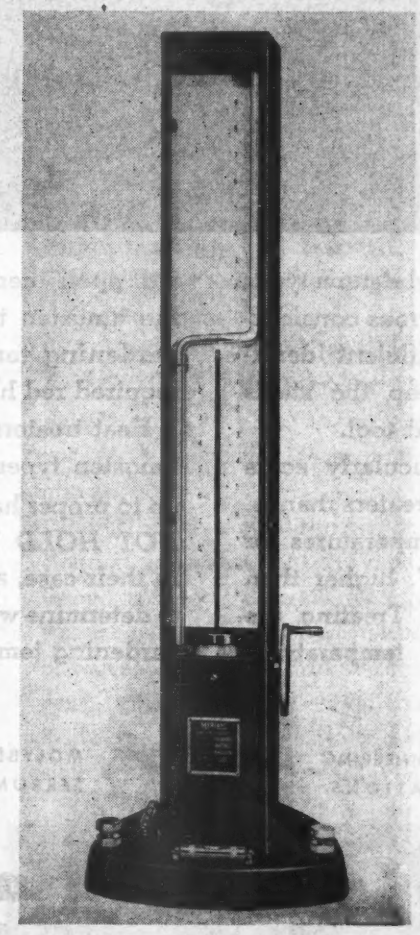
Used for both hand and machine dressing, "Handi-Nib," new double purpose diamond dresser tool made by Diamond Tool Co., Chicago, consists of ejector type handle in combination with "Big-Hed" diamond nib held firmly in handle for use on steady rest of grinder wheel. To release nib for use in adaptor rod of center grinder or other machine taking 7/16 in. shank nib, operator holds handle and presses down on elector rod. Nib may be pressed back into handle socket for hand use. Available with reset nibs containing diamonds of two carats and larger.—AVIATION, Sept., '44.

Synthetic Bonding Adhesive.....77

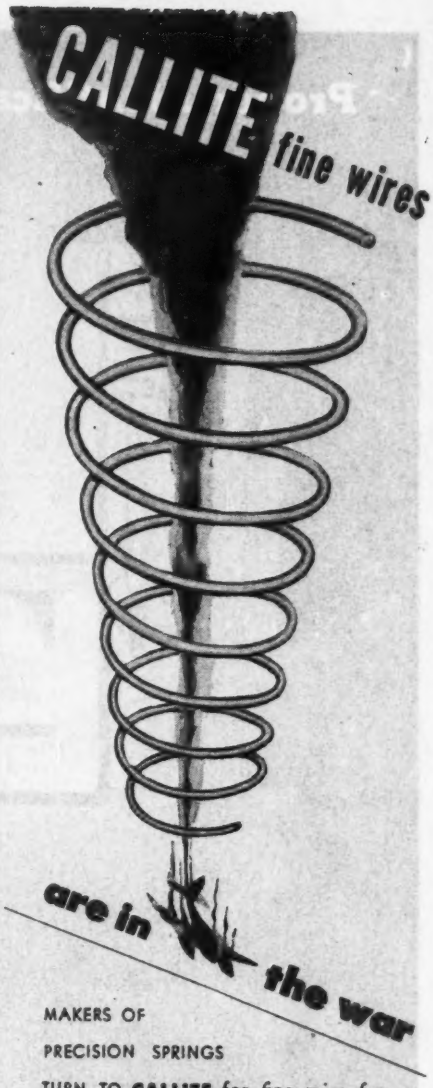
Synthetic adhesive for plywood bonding and heavy timber lamination is announced by Resinous Products & Chem. Co., Philadelphia. Known as "Amberlite" PR-75-B, resin is designed for aircraft work, including wing and fuselage assembly gluing, hollow spar construction, and scarf jointing.—AVIATION, Sept., '44.

Micro-Manometer 78

Designed for calibrating low pressure instruments and for reading pressures and vacuums, the Meriam micro-mano-



meter is offered for readings to plus or minus .001-in. water pressure. Maker is Meriam Instrument Co., Cleveland.—AVIATION, Sept., '44.



MAKERS OF
PRECISION SPRINGS

TURN TO **CALLITE** for fine wire for a myriad of war applications. For example: The Connecticut Spring Company, of Hartford, depend on Callite Wire for gun springs, for marine instruments, batteries and aircraft parts, bomb racks, and signal units.

CALLITE WIRE is always uniform, accurate in diameter, drawn to the optimum properties of the metal or alloy specified, and finished exactly right for their purpose. Our engineers are at your service. Callite Tungsten Corporation, 572 Thirty-ninth Street, Union City, New Jersey.

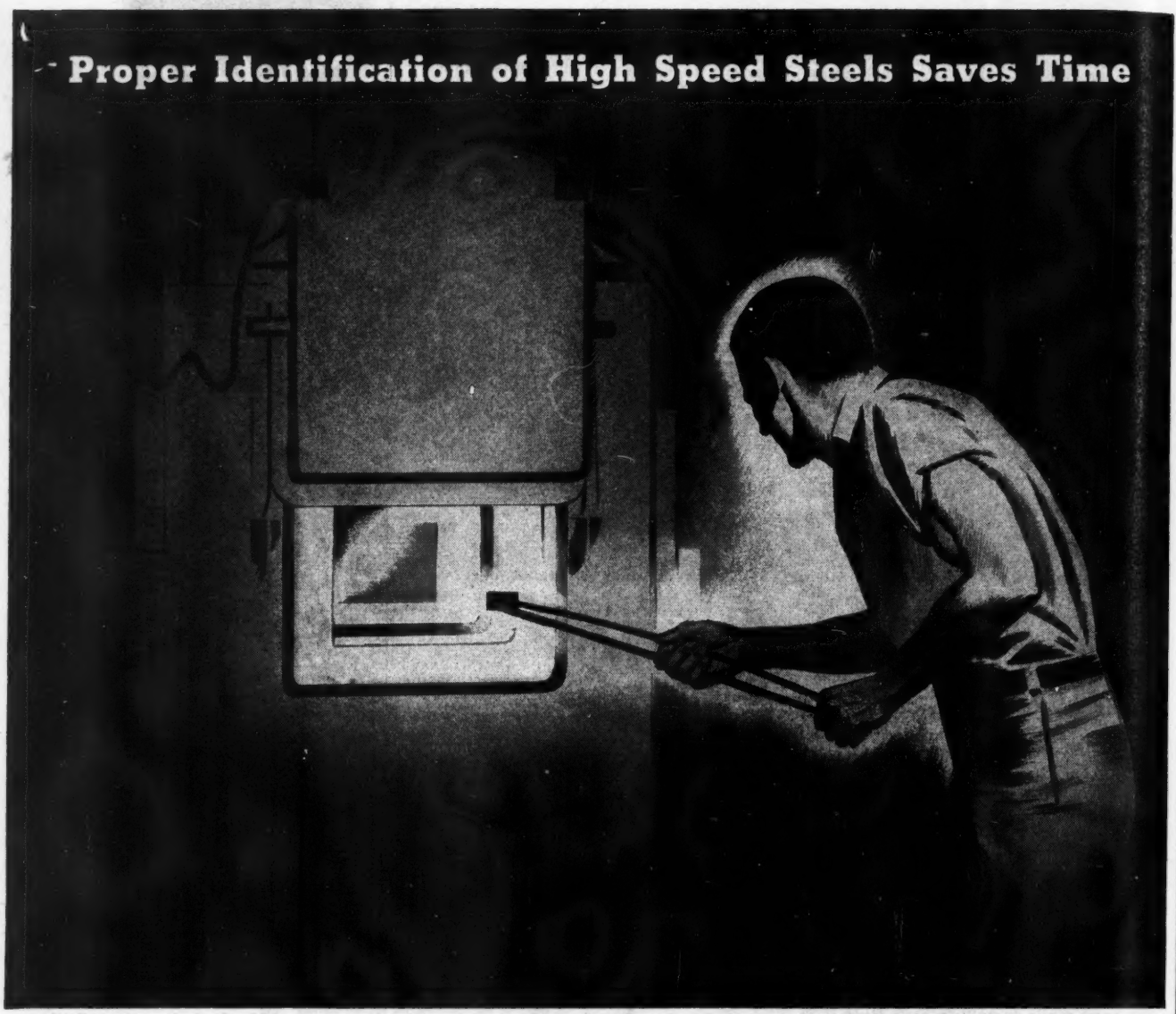
Branch Offices: Chicago, Cleveland.

CALLITE

FINE WIRES

Precision diameters down to .002 or smaller; in Aluminum, Phosphor Bronze, Beryllium Copper, Stainless Steel, Silicon Bronze, Silver, and Special Alloys, for springs, cables, instruments, wire cloth, brushes, bonding jumpers, etc., on spools or coils

Proper Identification of High Speed Steels Saves Time



Plants using both tungsten and molybdenum types of high speed steels should give serious consideration to the establishment of an efficient identification system—one that will keep the steels separated from bar stock to finished tool.

The danger of spoilage is particularly acute when mixed lots get into the heat treaters' hands.

The recommended hardening temperatures for tungsten types are 100° to 200°F. higher than those for the molybdenum types. Treating the latter so far above recommended temperatures will spoil them for cutting tool service. Treating the tungsten types that far below recommended hardening temperatures will not develop the required red hardness.

Heat treaters sometimes use the "sweating" of tungsten types as an indication that the steel is up to proper hardening temperature. *THIS DOES NOT HOLD WITH MOLYBDENUM TYPES.* In their case, a pyrometer should always be used to determine when the steel is at the recommended hardening temperature.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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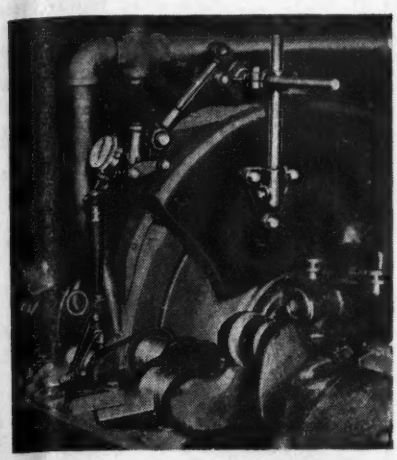
MOLY

Grinding Gage 79

Continuously measuring diameter of external cylindrical jobs while work is in progress and automatically indicating point at which correct diameter is reached, Pratt grinding gage, made by **American Diamond Tool & Gage Co.**, Detroit, is said to provide a continuous



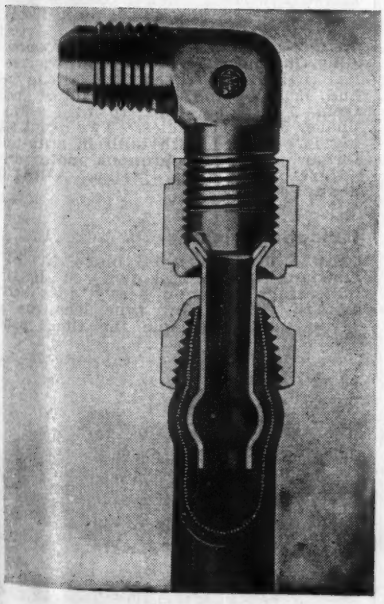
check on out-of-roundness and amount of error. It is reported that work is also automatically measured, without aid of hard calipering, while stock is being removed. Gage is adaptable to straight and tapered work, with dia. sizes from 5/16 to 27 in.—**AVIATION, Sept., '44.**

Radio Tube Tester 80

Designed for use in testing Octal, Loctal, Bantam, Jr., Miniature, Midget, and all acorn tubes, **Radio City Products**, New York, announces tube tester No. 314. Filament voltage switch tests all present voltages from 1.1 to 117 v. Lever type switching individually controls each tube prong, checks roaming filaments, dual cathode structures, and multi-purpose tubes. Separate plate tests on diodes and rectifiers. Neon short tests indicate leakage between two elements. Specifications: Size, 14¼x13x6 in., weight, 12¼ lb.—**AVIATION, Sept., '44.**

Flexible Hose Coupling 81

Weatherhead Co., Cleveland, announces new flexible hose coupling in which seal varies proportionally with pressure carried. Designed for instrument and low pressure hydraulic hose lines, floating seal involves assembly of steam and coupling nut, plus a free sleeve nut. Hose is run onto stem provided with annular hump. By reason of its wide angle gripping threads, sleeve nut, as it is turned onto hose, becomes an integral part of the hose. As pressure is applied, steam is forced out, pulling hose



and tapered sleeve nut against hump. Seal is tightened as pressure increases, and relaxes as pressure decreases.—**AVIATION, Sept., '44.**

Poppet Drain Valve 82

Designed to replace "Y" oil drain valve in aircraft, new poppet type drain valve produced by **Koehler Aircraft Product Co.**, Dayton, is reported to automatically close itself when not locked in wide open position, without aid of safety wiring.—**AVIATION, Sept., '44.**

Template Production 83

For removal of exposed negative paper from glass plate in photoprint process of template reproduction, **Turco Products**, Los Angeles, has new chemical solution named "Prosolv" which is stated to have ability to break bond between paper and glass in short period, so that paper peels off completely.—**AVIATION, Sept., '44.**

Segmented Shank Gages 84

N. A. Woodworth Co., Detroit, announces new Carboloy gage with seg-

mented shank stated to compensate for difference in coefficient of expansion between cemented carbides and steel, thus to assure trouble-free bond. Carboloy plug gages range in size from .510 to 1.510.—**AVIATION, Sept., '44.**

Giant Carbide Die 85

Carboloy Co., Detroit, announces manufacture of giant sheet metal die with carbide nib weighing over 100 lb. and measuring 9½ in. i.d. and 13 in. o.d.—**AVIATION, Sept., '44.**

Electric
LIGHT and POWER
for AIRCRAFT

● If you want quick, cold-weather aviation engine starting, — plus floodlights for night operation — your best bet is a Nite-Hawk Aero-Starter.

If you want power for testing turrets, landing gear and auxiliary apparatus, and checking circuits and wiring, the same Nite-Hawk starter will supply it. Floodlights are combined for night operations, too.

Operating independently of outside power sources, its 4-cylinder, 19-25 hp, air-cooled, gasoline engine drives a 500-ampere generator. Comes in three styles rated at 12 volts, 24 volts, and 12 and 24 volts, all 500 amperes. Mounted on skids or pneumatic tires.

For Nite-Hawk Aero-Starters, or for any other electrical equipment you may need to "keep 'em flying," your local GRAYBAR office is ready to give you one-source supply service. GRAYBAR's network of warehouses in more than 80 cities helps you fill your standard aviation electrical equipment orders easily—special items are delivered with the least possible delay. Call your local GRAYBAR office today.

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HEX-SOCKET SCREWS

The emblem of supremacy in the air signifies, too, the supremacy of the mechanical equipment that bears it up. Not only in the aircraft assemblies, but in the plants and tools that *make* the equipment, ALLEN products contribute to record-performance.

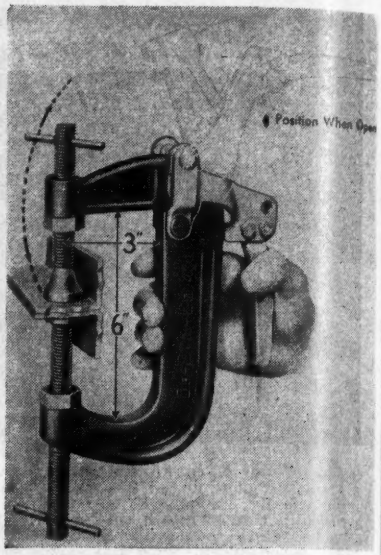
ALLENS have strength for set-ups with weld-like grip, not to be budged by shock-stresses or sustained vibration. Thread tolerances are held to a high Class 3 fit, for a high degree of frictional holding-power. . . Screws cold-drawn and *"pressur-formd"* of special-analysis ALLENOY steel, heat-treated under scientific controls. Hexagon sockets handily reached with Allen hex Keys in the hardest-to-get-at places. Adapted to high-speed assembling with power drivers.

Allen Hollow Screws and *"Tru-Ground" Dowel Pins supplied only through Industrial Distributors in all centers.*

THE ALLEN MANUFACTURING COMPANY
HARTFORD, ★ ALLEN ★ CONNECTICUT, U.S.A.

Toggle Action "C" Clamp 86

Detroit Stamping Co., Detroit, has developed new toggle action "C" clamp having two adjustable spindles to grip work at any point, permitting clamping over double angles and irregular shapes. Each spindle is locked into its place and



it is stated quick clamping and release are effected by rapid toggle action. Upper portion of clamp swings clear of work upon release, and toggle handle may be adjusted to straight out or downward position by changing location of retaining bolts. Clamp, 6 in. in size with 3 in. throat, is called "De-Sta-Co" Model No. 480.—**AVIATION, Sept., '44.**

Solderless Knife-Disconnection.....87

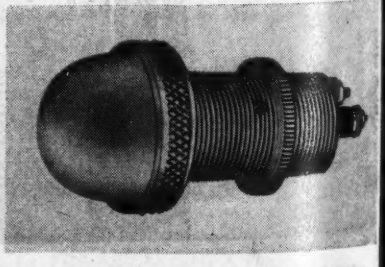
Connection and disconnection is reported quickly made with soldering knife-disconnect terminal developed by **Aircraft-Marine Products,** Harrisburg, Pa. Switches which have tabs extending from contacts to which external connections are soldered may be converted by replacing contact members with members embodying knife-disconnect end. Switches which have screws or binding posts may be converted by attaching disconnect tab thereto. Knife disconnect lends itself to use as soldering tab, for emergency repair, since wire may be bound about hook; or solderless connection may be made by wrapping conductor alternately around tongue and under hook, squeezing hook closed.—**AVIATION, Sept., '44.**

Cage Motor Starter..... 88

Designed to protect motors from sustained overloads, locker rotor conditions, single-phasing, and overloading from frequent starting is new magnetic, reduced voltage cage motor starter. Produced by **Allis-Chalmers Mfg. Co.,** Milwaukee, it has calibrated thermal overload relay and is available for control of motors from 5 to 2,500 hp. up to 5,000v., 3-phase, 50 or 60 cycles. Two point starting is obtained with built-in auto-transformer, using synchronous motor driven adjustable timing relay.—**AVIATION, Sept., '44.**

Indicating Light 89

No. 590 D/E unit, made by **H. R. Kirkland Co.,** Morristown, N. J., is an indicating light for heavy duty service on 120v., with new type lens cap and ⅞ in. mounting hole for thick panels.



Lens cap is threaded and contains heavy walled glass lens, cupped in shape. Tip of S6 120v. bulb extends into cup of lens which provides 180 deg. visibility and is available in red, green, blue, amber, and white, with sandblasted interior or in clear glass. Type T4½ Neon glow lamp may be used, and lens cap is available with connections for other type bulbs.—AVIATION, Sept., '44.

Sheet Weight Slide Rule.....90

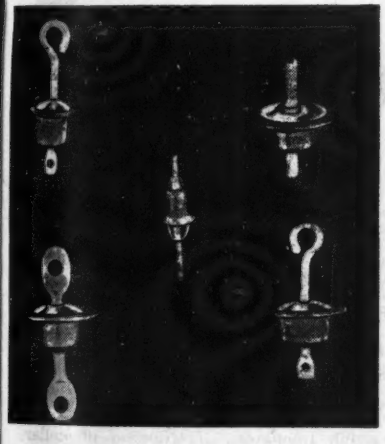
Slide rule offered by **Dayton Rogers Mfg. Co.**, Minneapolis, is for automatic calculation of weight of any steel sheet or strip relative to piece-part requirement as used for punch press stock. Operator estimates number of pieces and lineal feet, and rule gives over-all weight. There is also a conversion table for sheet aluminum, copper, bronze, and other sheet alloys. Piece-part weight is principally recorded after knowing weight of stock, including thickness, together with length required. This will calculate sheet from ⅛ to 96 in. wide, in thickness from .002 to 1 in., and in length from ¼ in. to 1000 ft.—AVIATION, Sept., '44.

Electro-Magnetic Clutch 91

Developed for use with small, high speed electric aircraft motors, new "Fastop" electro-magnetic clutch, made by **Lear Avia**, Piqua, Ohio, is designed to release motor rotor from load when circuit is de-energized, allowing rotor to run down at leisure while mechanism carrying load stops instantly. Principle involves an operating solenoid connected in series with motor. Of two solid metal disks, one is connected directly with rotor and the other with output shaft. Center portion of one disk is separated from rim by non-magnetic metal, so that this disk becomes a magnet when motor is energized. When energized, other disk is attracted and revolves at motor speed. When de-energized, two disks are about 0.010 in. apart.—AVIATION, Sept. '44.

Sealed Leads 92

Hermetically sealed leads made by **Electrical Industries**, Newark, N. J., are constructed of Pyrex glass with Kovar



electrodes and metal collars. Leads are suitable for use in transformers, condensers, coils, and filters.—AVIATION, Sept., '44.

Quick Disconnect Couplings.....93

For use on fuel, oil, instrument, and air lines on aircraft, **E. B. Wiggins Oil Tool Co.**, Los Angeles, offers new quick disconnect couplings. To disconnect, pull back knurled ring; to connect, push ends of coupling together and slide ring forward. Incorporated is 4-way seal of synthetic rubber used with either standard "O" ring or square gasket, and it is out of line of flow. Couplings are available for line sizes ¼ to 1¼ in. for tubing or pipe, and ¼ to 2 in. for hose. There are other models for ¾ to 10 in. lines.—AVIATION, Sept., '44.

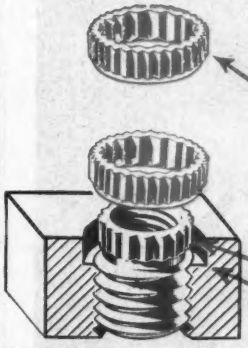
Plastic Thickness Gage.....94

Industrial Products Suppliers, New York, announces new multi-color plastic thickness gage. It has eleven leaves of different colors with thickness from .0015 to .030 in.—AVIATION, Sept., '44.

SALVAGE *those* CASTINGS

Damaged Threads Easily Repaired

With Rosán Locked-in Threaded Inserts, you can easily and economically salvage castings which have been rejected on account of damaged threads in tap holes.



Material has been drilled and tapped. Insert, minus locking ring, has been partly screwed into place

Insert locked in place. Inner serrations engaged with teeth of collar. Outer serrations broached permanently into material.

Once installed, Rosán Locked-in Threaded Inserts become a permanent part of the casting. Vibration, torque or tension will not disturb them, yet they can easily be removed for replacement, if necessary, by a simple, shallow drilling operation.

These inserts are locked in all materials by this locking ring ● which is serrated inside and out. The insert proper has a serrated collar ● which engages the inner teeth of the locking ring in the completed installation. When pressed or driven into place, the outer teeth of the ring broach the wall of a counterbore, ● locking the insert in place and making the whole unit an integral part of the parent material. ● Installations can be made in any material which is softer than the steel locking ring, including cast iron.

Salvage and Maintenance Departments: Write for full information and submit your fastening and salvage problems to our Engineering Department. No obligation.

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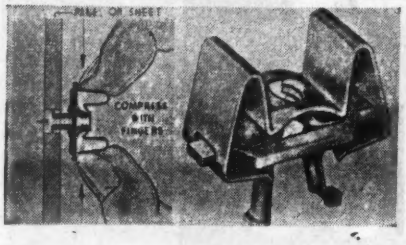
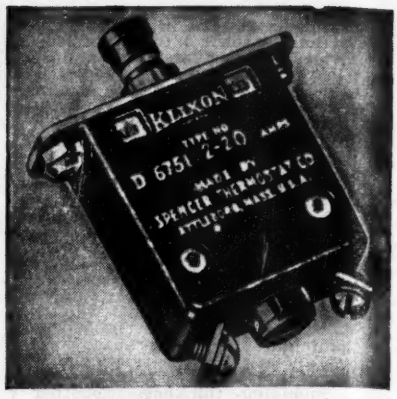
Speed Nut 95

Installation procedure in using new self-locking, speed nut for instrument mounting, made by **Tinnerman Products**, Cleveland, is to compress cage (shown in cut) and insert legs into standard .171-in. clearance holes. Legs spring apart when pressure is released, turned up ends clearing back side of panel. Nut will hold tight against force of inserting screw and screw tightening torque, and floating speed nut within cage allows for misalignment of holes. Available with legs or length to fit panels from .062 to .375 in. thick, speed nut and cage are made of non-magnetic materials.—**AVIATION, Sept., '44.**



Push-Pull Circuit Breaker.....96

New feature of "Klixon" D-6751 circuit breaker for aircraft is push-pull button, designed to permit manual opening so that repairs can be made without de-energizing entire system. Push-pull button travels outwardly approximately ¼ in. when pulled and exposed three-color band, part of which is luminous. It is available in ratings from 5 amp. through 50 amp. with standard mounting dimensions and suitable for 30 v. dc. systems. Maker is **Spencer Thermostat Co.**, Attleboro, Mass.—**AVIATION, Sept., '44.**



A. C. Electrode.....97

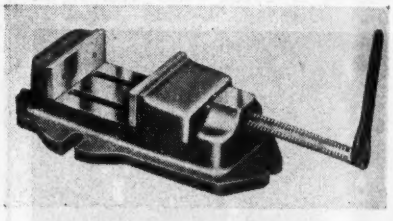
Lincoln Electric Co., Cleveland, announces new shielded arc electrode for mild steel, designed for operation on a.c., but which also operates on d.c. with either polarity. Named "Fleetweld 35", it is available in ⅛, 5/32, and 3/16 in. sizes.—**AVIATION, Sept., '44.**

Metallizing Gun 98

Metallizing gun made by **Metallizing Eng. Co.**, Long Island City, N. Y., sprays lead, tin, copper, and other low melting point metals at high speeds. Type 3E is equipped with universal gas head allowing tool to be operated on any commercial gas in conjunction with oxygen and compressed air.—**AVIATION, Sept., '44.**

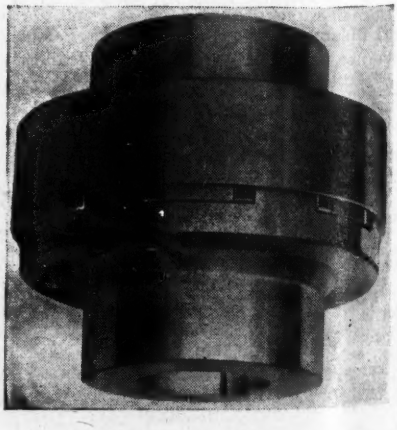
Heavy Duty Vise.....99

Mechanics Engineering Co., Jackson, Mich., announces new fast locking heavy duty vise, Jenkins "Bar-Lok", which is set and released by means of push-pull pressure unit locked at four points and developing pressure to 20,000 lb. Quarter turn of handle locks and releases. Four-inch opening is said to be equivalent to ordinary 6-in. vise. Height is 3½ in., with jaws 1⅝ x 4¼ in.—**AVIATION, Sept., '44.**



Shrouded Flexible Coupling 100

Safety feature reported for L-R type "C" shrouded flexible coupling, made by **Lovejoy Flexible Coupling Co.**, Chicago, is outside steel collar which holds load cushions in place. Extension of collar, which encircles coupling, safeguards materials and fingers from bolt heads. Couplings are designed for services from



Forgings—laboratory controlled—strength, toughness—minimum weight that stands up under unpredictable loads.

WYMAN-GORDON

WORCESTER, MASS · HARVEY, ILL. · DETROIT, MICH.

4.60 to 806 hp. at 100 rpm. Available are types for direct attachment to fly wheel, also drum types and others for rapid disassembly without disturbing equipment.—**AVIATION, Sept., '44.**

Portable Oil Filter.....101

New portable filter for aircraft engine oil is announced by **General Filters, Detroit.** Model AF-1400 has gas engine driven rotary pump which draws oil from engine through suction hose. Oil is circulated through six full-flow filters and returned to engine in about 15 min. Complete assembly fits in back seat of jeep. Filtration is designed to be positive to fineness of 5 microns, and each filter cartridge has area of 1,000 sq. in. No chemical treatment, which might change oil specifications, is involved.—**AVIATION, Sept., '44.**

Portable Conveyor 102

New type of portable conveyor for use in aircraft plants is reported light enough to be carried by hand yet strong enough for its purpose. Maker is **Island Equip. Co.,** New York. Units are available in 12, 18, and 24 in. width, standard length, 10 ft.—**AVIATION, Sept., '44.**

Flush Riveting 103

Designed for high speed flush riveting on irregular or slightly curved surfaces, new flush riveting set is announced by **Emerson Engineering Co.,** Los Angeles.

Swivel action allows riveting from various angles up to 20 deg. Sets have 1¼-in. face with overall length of 3 in., and are available with either .401 or .498-in. shank. Set consist of three parts: head, shank, and rubber retainer.—AVIATION, Sept., '44.

Precision Gages 104

Made of steel, chromium plate, or carbide line of precision gage is offered by **Crescent Die & Tool Co.,** Lincoln Park, Mich. Plug, ring, flat plug, profile, flush pin, snap, and build-up gages are available in full range.—**AVIATION, Sept., '44.**

Flight Instruction Technique

(*Continued from page* 175)

force required to move them. This suggestion is made since the force required varies with speed and may be relatively high in a steep bank even when close to the stall. In contrast their effectiveness in controlling roll is more directly associated with the angle of attack.

Instruction in the use of the rudder may present a problem. Recognition and control of skid or slip is something new for the embryo pilot and it is not impossible that there are some who cannot be taught to recognize skid or slip except by instrument.

It is the author's belief, shared by some but not by all, that skid and slip can be detected in a closed cockpit without instruments only by feel. Visual clues are not reliable. The eye cannot detect the direction of movement of the airplane relative to the air which determines skid

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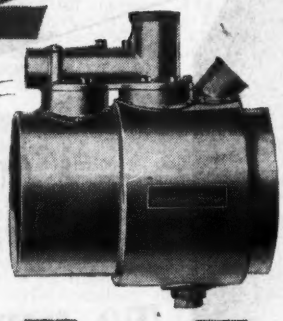
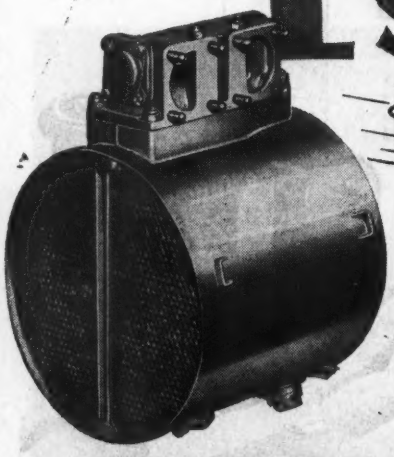
1932



A pioneer aircraft oil cooler. Diameter 5 inches, with short warm-up "muff" indicating limited thaw-out requirements. Built by Young for the U.S. Army Air Force.

1944



Present Young aircraft oil cooler. 10 inches in diameter, almost four times the heat transfer capacity and five times faster warm-up. Built by Young for military and commercial use.

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or slip but can only detect its movement relative to the ground. The two are identical only when there is no wind. When there is a wind, drift cannot be differentiated from skid or slip by vision.

If this is so, then correct rudder use without instruments can be learned only by those who can learn to detect skid or slip by feel.

Recent experiments by Herman Witkin at Brooklyn College have indicated that there is a wide discrepancy between individuals in their ability to detect an unbalanced condition by feel when visual clues interfere. In these tests, the subjects were placed on seats which could be tilted sideways and which were mounted in a room which could also be tilted independently of the chair. Although some subjects would detect departure of the chair from level irrespective of the angle of tilt of the room, others could be tilted through wide limits without detecting any tilt if the room were tilted at the same time so that the chair remained parallel with the floor of the room. These same subjects would believe the chair to be tilted when it was level if the room was tilted. Similar results were obtained with the same subjects when placed in a room which could be made to travel on a circular track but could not be tilted. Those who could detect unbalance reported that the room and seat appeared tilted when they were subjected to centrifugal force. Those who could not, reported that the room and seat remained level during rotation.

The author is not aware of any test having been made to determine whether those who could not detect the unbalance could be taught to do so and it is possible that some might find extreme difficulty in acquiring this ability. For such people instruction in the use of the rudder by feel might take a considerable amount of time, or even be impossible. In such cases, it is believed that the student might preferably be taught not to use the rudder in the air except as indicated by instruments as the stability of the airplane with rudder neutral would at least prevent the excessive skidding or slipping which might otherwise result.

The elevator is not only the most hazardous of all airplane controls but its proper use is the hardest to teach.

Skids and slips generally are not hazardous in themselves. They only become hazardous when the airplane is stalled, and when it is stalled misuse of either the rudder or ailerons—or even a healthy bump—can result in a spin. However, skids and slips can and do lead to misuse of the elevators. As a result improper use of the rudder or ailerons is often charged with direct responsibility for accidents which would not have occurred if the elevators had not also been improperly used. If flight in the stall condition were a necessary part of flying, then it might be proper to charge spins from stalls to the rudder or ailerons and instruction might well be concentrated on their proper use under this condition. Since it is not, and spins result usually from unintentional stalls, instruction should be concentrated on their avoidance.

The difficulty in teaching proper use of the elevators arises from two sources. First, their proper function is to control the flight path relative to the airplane and the direction of this path is difficult (at times impossible) to discern; is not indicated by the position of the nose on the horizon; and is not recorded by any instrument now commonly used. Second, there is a reversal in their secondary effect, i.e., on the direction of the flight path relative to the ground.

Strangely, the most important part of instruction in the use of the elevators is in their effect upon the flight path relative to the ground, not to encourage but to discourage their use as a control of this path. It is perfectly natural for the embryo pilot to have an instinctive feeling that the airplane follows its nose and that holding the nose up with the elevator will extend his glide or increase his climb. Hence, he is faced in his first experience in controlling movement in the vertical plane with a control which appears to be the proper one but is not. His control response which appears to be meeting his expectations when as a matter of fact it may be doing just the opposite, and he has no way of discerning which it is doing.

Instruction in the use of elevators should not be on their effect on the position of the nose. Such instruction only tends to strengthen the novice's natural assumptions that the position of the nose is an indication of the angle of climb or glide. In contrast, the instruction should be upon the effect of the elevator on the inclination of the flight path relative to the ground and the lack of any relationship between that path and the position of the nose. It is insufficient that the embryo pilot be told there is a reversal in the effect of the elevators on flight path inclination or that this be simply demonstrated to him. Unless it is driven home to him by constant drill he will unconsciously revert to his natural inclinations under stress and will attempt to stretch a glide or increase a climb by pulling back on the stick.

Effect of the elevator upon the flight path is not changed in a turn, nor does it become a control of the radius of turn. Any change in radius of turn which accompanies movement of the elevators is due to the change in speed occasioned thereby, not due to an increase in the lift force. Except for a slight inclination of the lift force and the propeller thrust due to the angle of descent or climb, it should be manifest that the vertical component of the lift force must always equal the weight of the airplane.

If the angle of attack is changed with the elevators the inclination of the flight path in the vertical plans will readjust itself to attain a speed which, with the new angle of attack, will again make the vertical component equal to the weight. Hence, the elevator has the same effect upon the inclination of the flight path in a turn as it has in level flight and does not directly effect the radius of turn. Also, there is exactly the same reversal in elevator effect on path angle in the turn as there is in level flight. If students are taught to recognize these char-

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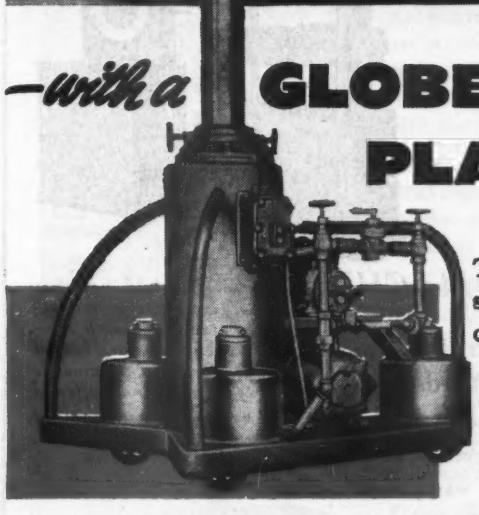

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acteristics, there is not much likelihood of their stalling in a turn in an effort to maintain altitude with the bank too steep for the power being used.

Control of the flight path in the vertical plane should be assigned to the throttle.

In most instruction the throttle has had two, or at most three, positions—closed, open, and cruising. This left to the elevator all changes in flight path for the three settings. This sort of instruction definitely encourages the student to think of the elevator as the proper control of flight path and is, in the author's opinion, bad practice. It is contended that flying would be much safer if pilots used three positions of the elevator, those giving maximum efficiency, best climb, and minimum safe speed, and used an infinite number of throttle positions to control the altitude.

There are perhaps two reasons for the present practice. One; the throttle also effects the air speed in most airplanes. Two; it is desired to teach the student to make landings without dependence upon power.

The first item is readily disposed of. Although it might not always be desirable to so construct the ariplane that the throttle does not effect air speed, it would not be difficult to connect the throttle with a trim tab to accomplish the same result. The author can state from experience that there is a distinct feeling of assurance against an unintentional stall in airplanes in which the throttle can be used to control flight path without simultaneously changing air speed.

In regard to the second item, the author can see no conflict between teaching the throttle as path control and teaching landings without power. He can see an advantage in this form of instruction in that it would discourage the student from attempting to correct for a mistake in starting his landing glide by use of the elevator.

It is suggested that carrying this instruction into maintenance of altitude in turns with the throttle would help to give the student a clear conception of the requirements of this maneuver which would in turn help to guard against stalls from turns.

Explanation of turns as they are commonly taught, is, to say the least, far from simple. In the turn the lift force has to increase at such a rate that its vertical component always equals the airplane's weight. This requires either an increase in speed and hence in power if the angle of attack is not changed or an increase in angle of attack and increase in power if the air speed is not changed.

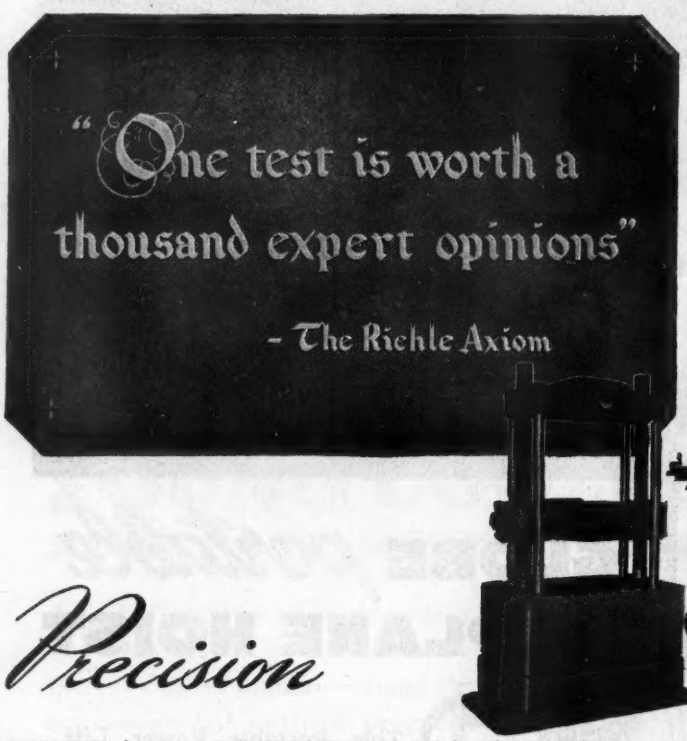
If the turn is made from level flight without increase in power and without change in altitude, then the angle of attack must be increased and the speed decreased. The decrease in speed results from the fact that with a higher angle of attack the drag is also higher and the drag multiplied by the speed can only equal the power being used if the altitude is maintained. Hence, we have the requirements in such terms of a decrease in speed when the stall speed has been increased.

In teaching the use of the throttle to maintain altitude in the turn it is suggested that the turn be made with several elevator positions to demonstrate that steeper banks and shorter radii of turn can be accomplished without loss of altitude at the lower speeds.

When this article was started the author contemplated pointing out various ways of making the direction of the flight path more easily recognizable than it is in normal flight maneuvers to permit proper instruction on the effect of the elevators on the flight path. But none were very satisfactory for the purpose intended and it is so simple to provide an instrument which will indicate flight path that it seems little short of foolishness to attempt to get along without it. By attempting to do so we add appreciably to instruction problems and instruction time.

At the start of this article the author disclaimed any originality in the ideas presented. The reason is this: The first powered airplane was equipped with a flight path indicator which the first students of flying, the Wright Brothers, found extremely useful. In their case it consisted of a string tied well forward in undisturbed air. All that is now required is a weather vane similarly situated and actuating an indicator in front of the pilot.

This indicator could indicate angle of yaw—not correctly indicated by the pres-



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ent ball-bank meter; angle of attack—not correctly indicated by the air speed meter; and angle of climb or descent—poorly indicated by the rate of climb meter, as well as pointing in the direction of motion. It could be calibrated in air speed for a given gross weight and its scale could be marked to show angle of attack for maximum glide, for best climb, and for most economical cruising and the danger area between maximum efficiency and stall could be clearly indicated.

It must be conceded that if skid and slip are detected by feel the natural correction is to alter the bank. Unfortunately the present ball-bank, resembling as it does a spirit level, encourages the same kind of correction. While neither of these objections to the use of the rudder for skid control is believed to be sufficient to effect the arguments in favor of such use, it is recommended that we adopt some other form of skid indicator which will not have this objectional feature. The English use a needle, similar to the turn needle, to indicate skid, and this would seem to be preferable to our ball-bank meter.

In conclusion, and bearing out the author's disclaim of originality, the following excerpt from the book "The Wright Brothers," by Fred C. Kelly is submitted.

"The court in Germany made the comment in its oral decision that their (Wright Brothers) discovery that a rear rudder was a balancing device rather than a steering device should entitle them to a basic patent."

Save Money by Spending It

(*Continued from page* 131)

Returning to the hypothetical airplane with flaps and retractable gear as listed, it may be noted that whereas there is an 80-lb. saving in gross weight, there is only a 52-lb saving in the weight empty. This is because 28 lb. out of 80 represents fuel saving for the assumed equal range. At present production costs, this 52 lb. saving in weight empty represents a net saving of well over $100. Another way of looking at it is that the extra weight of the landing gear is more than made up in the power plant alone, besides a considerably larger saving in the fixed structure. These estimates are of course based on reasonable production quantities and do not deny that redesign costs must be taken into account.

Concluding Discussion

There are several further advantages, aside from reduced cost of the modified airplane, that make it preferable. General sales appeal would certainly be superior. The lower fuel consumption and generally lower power plant up-keep should more than make up for the increased inspection and up-keep required for the retracting mechanism. Although the modified plane is assumed of equal span, it can be made slightly shorter due to the smaller power plant and reduced tail length. The propeller may also be of slightly smaller diameter, allowing for either increased ground clearance or reduced height of

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landing gear. Although proportioned on a basis of equal landing speed, the modified design would have actually shorter landing characteristics due to the steeper glide path and shorter landing run permitted by the flaps. At the same time, the lower drag with flaps up will provide a flatter gliding angle when desired.

A final check of climb shows that under steady conditions the actual rate will be decreased from 600 to about 500 fpm. This disadvantage is believed offset, however, by the greater flexibility of control afforded by the flaps, making it easier to clear a local obstruction. Some kind of warning will doubtless always be necessary to remind the absent-minded pilot that his wheels are up. Simplified control arrangements and measures to limit stalling are also highly desirable.[3]

As the assumed airplane is a low-wing type with tricycle gear, the figures cannot be used for other types without some modification. With the high wing, the original landing gear drag and the corresponding importance for retracting it will be greater, but the difficulty of retraction is also increased. In many cases a complete redesign is probably better than attempting to use a basically unsuitable type. More broadly, the analysis here presented is not claimed to be more than a fair example of what can be done. But to the extent that these figures can be taken as representative of light planes in general, they show that, far from being deluxe extras, even for a speed as low as 100 mph. flaps and retractable gear should be regarded as must items, dictated by all-around economy if nothing else.

[3] "New Developments in Simplified Control" by R. H. Upson, *Journal of the Aeronautical Sciences*, Vol. 9, No. 14, Dec. 1942.

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ONE of the principle advantages of chromium is its ability to resist corrosion.

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★ *This is number 2 in a series of articles by the Dearborn Gage Company on chromium plating.*

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Astralidade

(*Continued from page* 173)

approximately 900 ft. on the circle, and for practical purposes it is neglected.

4. The annual retrogression of the vernal point is taken into consideration, and a special device permitting a correction is adapted.

5. Actually, the star Polaris is at 1 deg. from the true Pole, and due to the annual precession of the equinoxes the declination of Polaris is decreasing toward the Pole, with a corresponding error. This is taken into consideration by a simple device and scale.

6. A special scale permits correction of the atmospheric refraction.

7. The 366 days of leap year are carefully taken into consideration.

Calibration of the instrument is closer than observation permits and closer than actually necessary for aerial avigation. Further, mechanical accuracy is closer than observation permits and closer than necessary for avigation.

Stabilization Accuracy

Referring to the vertical stabilization, in avigation groscopic stabilization is quite different from that of aerial bombardment. In the latter, the time element and mental reaction of the observer while he is under combat strain, considerably alter observation of the gyro level, which may be off the vertical at the bombing instant. During bombing the gyro is under rapid and unexpected tactical bombing maneuvers. In peacetime, when making a star observation, the plane would fly as smoothly as possible, and time could be spared for setting of the vertical of the instrument.

Now, by means of bubble levels and leveling screw, the astralidade can be leveled within ± 1 min. from the vertical, and so the total error due to stabilization may be approximately ± 2 min. and ± 3 min. of arc, from its original setting.

Referring to the azimuth stabilization, as above mentioned, if a long period gyro is used, it may be assumed that when the azimuth dial of the gyro system has been set to its true North, either by means of Polaris or magnetic compass with declination corrected, the true North orientation may, for a period of a few minutes of time, be maintained within an accuracy of approximately ± 1 or 2 min. of arc.

True North Accuracy

For transoceanic avigation of long duration, the true North is of basic importance. When Polaris is visible the astralidade can rapidly be orientated to the true North within 1 min. of arc or less—that is, much

closer than the reading obtained by modern magnetic compass.

It may be argued that Polaris may not be visible, obviously not during day flight. Quite true, hence in this case the most dependable means to determine the true North is still the magnetic compass combined with the magnetic declination correction. It may be assumed that this system is giving a true North accuracy within 30 min. of arc.

Probable Total Error

Assuming an error of ± 2 min. of arc, due to observation, combined with a ± 1 min. of arc mechanical error, it may be deduced that the total probable error may not exceed ± 3 min. of arc, or approximately 3½ mi. error on the circle if true North has been determinated by means of Polaris and the special correction method. This probable total error will be greater if the true North is set according to the magnetic compass.

Flight Operation

It is assumed that the instrument is properly stabilized and orientated toward the true North. In the following example we assume the star Vega is visible and the date is Mar. 28.

(A) Set guiding pointer 10 on Vega (engraved on globe) and make correction for atmospheric refraction.

(B) By means of latitude control and date circle control, set the sighting line of telescope on the actual star Vega and at the instant of coincidence with the reticle, read sidereal Greenwich chronometer and read latitude in deg. and min. of arc on latitude scale.

(C) Read sidereal time at intersection of Mar. 28 and time scale. The longitude will be the difference between Greenwich sidereal time, indicated by the chronometer, and the observed time on scale.

Two consecutive star observations made at short intervals will enable the avigator to determine his true ground speed.

Operation When Sighting Sun

(A) Set date on zero hour index of time cycle and make correction for atmospheric refraction.

(B) Set guiding pointer 10 on ecliptic traced on globe, and by means of latitude control and date circle control set sighting line on the sun, at which instant read Greenwich mean time on chronometer.

(C) Read latitude on latitude scale, noting difference between Greenwich mean time, and the time read at intersection of date gives longitude.

Note: Instead of using the globe, the inner altitude circle can be set according to the right ascension scale and the telescope according to the altitude scale, which would necessitate tables. The moon and planets also can be used to determine position. If it is desirable to use tables, the globe can be suppressed, the size of the instrument would be reduced, and the astralidade would be employed similar to a theodolite.

Setting To True North

A. The astralidade is set toward Polaris, which gives the approximate latitude within 1 deg.

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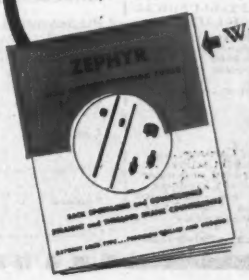

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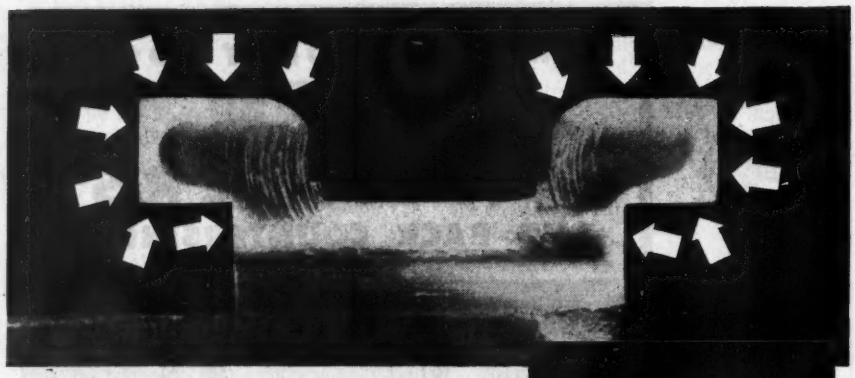

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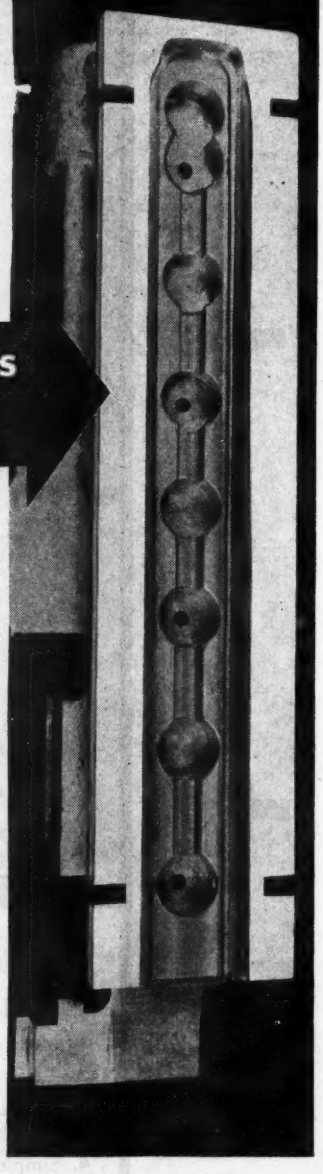

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B. Make observation on a known star. This gives the approximate local time.

C. Make atmospheric refraction correction, read time on Polaris reticle at intersection of time scale, and correct telescope accordingly. Finally, reset the telescope on Polaris and clamp astralidade on gyro-stabilized platform, thus the true North is determined within less than 1 min. of arc, which also permits the checking of the magnetic declination.

If Polaris is not visible, proceed as follows: Set approximate true North according to magnetic compass and approximate declination. Make observation on a known star, the moon, or sun, thus obtaining the approximate latitude and longitude of the position and permitting making of the proper magnetic declination correction. Then reset the orientation of the astralidade accordingly and clamp it to the gyro system.

Winter Maintenance In Alaska

(*Continued from page* 161)

mechanic desired. Men unfamiliar with great cold have found that a metal bolt at 30 deg. below zero has the tenacity of glue and the only way of separating it from his hand is at the cost of a small slice of skin.

Hangared ships present a problem when they are brought from the warm temperature of the hangars to the cold outside temperature in that frost forms very rapidly on the wings and cannot be removed unless the ship is brought back into the hangar and warmed. Winter operation is sometimes delayed because of this and any solution that our readers might have to the problem will be very welcome. Wing covers, of course, have been used but not too successfully.

Batteries cannot be left in ships that are not kept in a hangar as they will freeze if left out and be absolutely no good. At La Guardia Field, or any large airport in the states the airline passenger is familiar with the battery cart which is wheeled out under the ship at the time the engines are started. Alaska Airlines uses the conventional cart with fire extinguisher et al, but it is placed on a small sled made especially for this purpose and resembles a miniature dog team.

Many of the ships are fitted to take either wheels or skiis, depending on snow conditions at various airports at which they stop. Common practice is to plow one runway of the airport and leave the other as is, or roll it. Sometimes one strip will be cleared and sanded for wheel ships; with the one alongside packed with snow for skiis. When the snow begins to melt is when trouble really begins, in that slush freezes in the actuating mechanisms of landing gear and flaps. The inspector and line maintenance crew must be ever on the alert for this as well as to check freezing of brake bands and drums in very cold weather.

Many of the airplanes operated in Alaska today are of vintage unknown to the newcomer to aviation in the States. Alaska Airlines operates Stinson A's, Ford *Trimotors, Pilgrims,* Vultees, Bel-

lanca *Pacemakers* and *Skyrockets*, Lockheed *Vegas*, *Orient Electras*, and *Lodestars*. It requires a great deal of work and ingenuity to keep this large variety of craft in the air and busy transporting cargo, mail and personnel throughout the Territory, thus helping Alaska to beat the Jap.

Many ships are fabric and emergency repairs sometimes are not in strict accordance with C. A. R. One case in point was that of a small operator, who had a rip on the side of a ship which took place when landing on the tundra near Nome. A chill wind from the Arctic brought the temperature to about 20 below and the emergency tape would not adhere to the fabric. Finally in desperation the pilot poured water over the rip which froze solid and held the tear in place. This is not recommended, however, as the whip stream soon made short work of it.

Working in the open where hangars are not large enough to house the modern ships has given rise to the development of a new type of architecture which resembles that designed by the famous Chick Sales, except that this particular unit is placed on stilts. It is known as a "nose hangar" and is pushed up to the nose of the aircraft and the mechanics work inside the three-sided house thus protected (?) from icy blasts and cold.

Athough not strictly a maintenance function, it is the responsibility of the Maintenance Department to check winter emergency equipment which is placed aboard all aircraft operating in Alaska. Planes have been known to be forced down and passengers and crew must live in the midst of a land where there is one person to every ten miles, but unfortunately, not distributed in that particular manner, until assistance arrives. Alaska Airlines now carries on a Lockheed *Lodestar*, named *Starliner Anchorage*, the following emergency equipment: 17 full breakfasts, dinners and suppers, plus three additional tins of food, totaling 124 pounds. Of course people are not expected to live on this for over ten days as hunting and fishing are the two things in Alaska which everybody does in his spare time, and game and wild birds abound beyond belief. Fish normally grow to sizes which people lie about in the states. It is expected that emergency rations will be returned when the ship is finally located. Snowshoes, rifle and shells, axe, frying pan, cooking pots, dishes and fish lines are included in the plane's emergency equipment.

This list is merely partial. Beyond that there are sleeping bags, tools, ropes, even spare spark plugs, wing covers, motor covers, ad infinitum.

There are many problems arising daily in winter operations and maintenance, but if a complete list were to be compiled it would go on indefinitely and then only cover what had happened to date. Each day brings its new surprises and solutions. With modern equipment, large hangars and simple maintenance problems such as are faced in the States, your Alaska mechanic would indeed consider life easy and long for the difficulties he now grumbles over.

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PARKER

Shape of Things to Come

(*Continued from page* 181)

the disadvantages inherent in the more usual swept-back type. Although a rather higher max. C_L may be obtainable, it is likely to be at the expense of undesirable tip stalling characteristics. Moreover, the deepest section of the wing cannot be used to accommodate the load and a fuselage must be provided if passengers are to be accommodated.

A study of the tandem wing types built hitherto would suggest that they are basically inefficient, but there appeared to be no fundamental reason why it should not be possible to build an efficient tandem winged aircraft; so it was with this object in view that our *Libellula* layout was evolved. This is essentially a reversed tandem wing aeroplane in that the leading wing is of smaller area than the rear wing and yet is not merely a horizontal stabilizer in that it carries a substantial proportion of the total load.

This layout was evolved toward the end of 1941, and in order to test its feasibility with the minimum expenditure of time and money, a rough mock-up, the M-35, was designed, built, and flown within the space of six weeks.

This little machine, crude and inefficient though it was, demonstrated beyond any shadow of doubt the feasibility of the layout. Moreover, it provided us, quickly and cheaply, with much invaluable full-scale data enabling us to proceed, as the next stage of development, with the design of a more refined twin-engined model, the M-39B.

It might be well at this stage to enumerate the various advantages which we hope to achieve in the ultimate development of the *Libellula*.

1. Both leading plane and mainplane contribute to the total lift of the aircraft, and consequently the parasitic drag which is associated with the tailplane of an orthodox machine is eliminated. Tail unit drag for a clean aircraft often amounts to 10 percent.

2. With the conventional wing-tailplane system, the nosedown pitching moment, which is associated with center of pressure movement due to increasing incidence, calls for a maximum negative lift from the tail unit at the very moment when the greatest overall lift is desired. This undesirable feature is greatly aggravated when high-lift flaps are fitted; the highly efficient extending aerofoil type are the worst offenders. With the layout under review the lift of the two planes is additive, and backward movement of the C.P. calls for an increased lift on the leading plane to maintain trim.

3. The division of lift between two wings, as on a biplane, and the prospect of achieving an increased overall C_L should make a reduction in span possible, with a consequent saving of structure weight.

4. The elimination of the tail and the concentration of the power plant weight near the C.G. should also result in a considerable reduction in length and structure weight, and this feature, together with the reduction in span should result in increased maneuverability.

5. The above-mentioned feature may be of great importance in connection with the gas turbine power plant where the ratio of consumable load to fixed load must be considerably higher than that associated with a reciprocating engine and airscrew. It also greatly facilitates a submerged installation in the case of a central power plant.

6. Tricycle landing gear lends itself more readily to such a design than to the orthodox aircraft, on which poor dynamic qualities often lead to discomfort when taxiing and sometimes to structural failure. The damping effect of the front plane may make it possible to reduce the weight of the nose-wheel installation.

7. The field of view is greatly improved, particularly in a single-engined arrangement where a pusher airscrew with its manifold advantages is the obvious choice. Moreover, the oil is thrown out behind instead of obscuring the pilot's windscreen.

8. For military purposes the advantages ensuing from the use of the whole of the fuselage for stowage of the bomb load and military equipment are obvious, while the layout is such that an almost unimpeded field of fire can be obtained. The smaller overall size gives greater safety by reducing the target area, and the greater concentration of the load and power plants makes for economy in armor.

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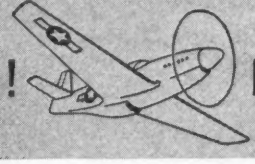
KEEP 'EM FLYING!  **BUY BONDS!**

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STITCH AT RIGHT ANGLES TO APPLIED LOAD				
1	549	160	240	232
2	554			
3	558			
4	568			
STITCH PARALLEL TO APPLIED LOAD				
1	480	135	205	232
2	493			
3	456			
4	469			

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9. For commercial aircraft the low drag which may follow from the reduction in wetted area and parasite drag would result in greater economy of operation. The loading advantages mentioned above, aided by the absence of wing spars and supporting structure running through the fuselage at the CG. of the aircraft, will make for greater convenience and comfort, while another important feature should be the maintenance of a more nearly level floor both on the ground and throughout the flight range. It should be noted that most orthodox aircraft pass through a fairly large incidence range when taking-off and landing, even if a tricycle undercarriage is fitted. The particularly good field of view for both pilot and passengers is also worth mentioning.

Apart from the relatively large range of permissible CG. movement which we hope to achieve with the *Libellula*, perhaps the next most important potential advantage is the reduction in structure weight which may be achieved, especially in very large aeroplanes.

At the present day, when we stand on the brink of an era of airplanes far larger than any conceived hitherto, we are faced with the likelihood of a seemingly unavoidable increase in the structure weight, particularly as regards the wing. This increase is almost entirely due to increase of span and, in the sizes of airplane now envisaged, it may well amount to something of the order of 5 to 10 percent of the all-up-weight as compared with existing types. Such an increment represents an increase of some 15 to 30 percent of the structure weight and, particularly in a long-range airplane with a small payload (whether in passengers or bombs), is a very serious shortcoming.

The reduction in span for any given wing area afforded by the Libellula layout may provide the necessary antidote and this, coupled with the further reduction in structure weight occasioned by the shorter fuselage and elimination of horizontal stabilizing surfaces may, in a large aeroplane, result in a reduction in structure weight of some 20 percent as compared with the corresponding orthodox plane.

These, then, are some of the possible advantages which may either wholly or partly result from the ultimate development of the *Libellula*. It would not, at this juncture, be profitable to indulge in any further speculation and it is clear that only an intensive program of full scale research can provide the necessary development of the design and pave the way to the realization of the hoped-for advantages.

It is not too much to say that the results so far obtained tend to confirm the prediction recently made by Dr. Roxbee-Cox when he said: "There is coming gradually a geometrical revolution—there is a big change, literally, in the shape of things to come.

Flange Rolling

(Continued from page 147)

back on itself until it approaches the back-up roll. Increase in diameter is prevented by the flange limiting roll which overlaps the back-up roll to control the final width of the flange.

Final stages involve the substitution of a flat finishing roll for the turning roll. This changing is performed manually and when this change has been effected, the roll is again fed into the flange and the forming completed.

In the final step the roll presses the flange against the back roll, flattening it out and forcing the metal outwardly against the control roll, thereby squaring-up the flange edges. At the same time, wall thickness is maintained by the space between the backing and conical rolls so that there is no reduction in the tubular wall.

Flange thickness is determined by the travel of the flat roll and by radial metal flow permitted by the control roll.

Keeping Motors Running

(Continued from page 163)

extinguishers handy. If a hose is used to spray either cleaning solution or varnish, make sure that the nozzle is grounded. Workmen should be guarded against breathing the fumes, and they should be under the close observation of someone familiar with artificial respiration. Where conditions are particularly bad, such as in pits, gas masks should be worn.

Varnish is applied after the motor has been thoroughly cleaned. Use a baking varnish recommended by the supplier for the particular conditions encountered. Two dips and bakes may be sufficient for normal conditions, while for extreme conditions of moisture four may be justified. One or two additional coats of synthetic enamel may be used under extreme conditions.

Dry the motor in an oven before dipping in varnish. Electric or steam heat is safest and most convenient. Make sure that suitable temperature control is provided to prevent injury to insulation. Maximum dry-out temperature is 115 deg. C. Baking temperature for varnish and length of baking period will depend on the type of varnish used.

Insulation tests are made to determine condition of the insulation rather than its quality. While special conditions may justify other tests, one to determine insulation resistance is generally all that is required in maintenance work.

Totally enclosed motors have the frames sealed so as to exclude the outside air. They are well protected against abrasive dirt and metallic particles that shorten the life of insulation in open motors.

For enclosed motors there are two points to observe: First, see that all exposed joints in the motor frame and brackets are tight. Use a water-resistant grease in the bracket fits, if the motor is dismantled. This will help to prevent accumulation of water in the bottom of the frame.

Second, make sure that the motor is provided with a drain at the bottom of the frame so that any accumulated water can be removed.

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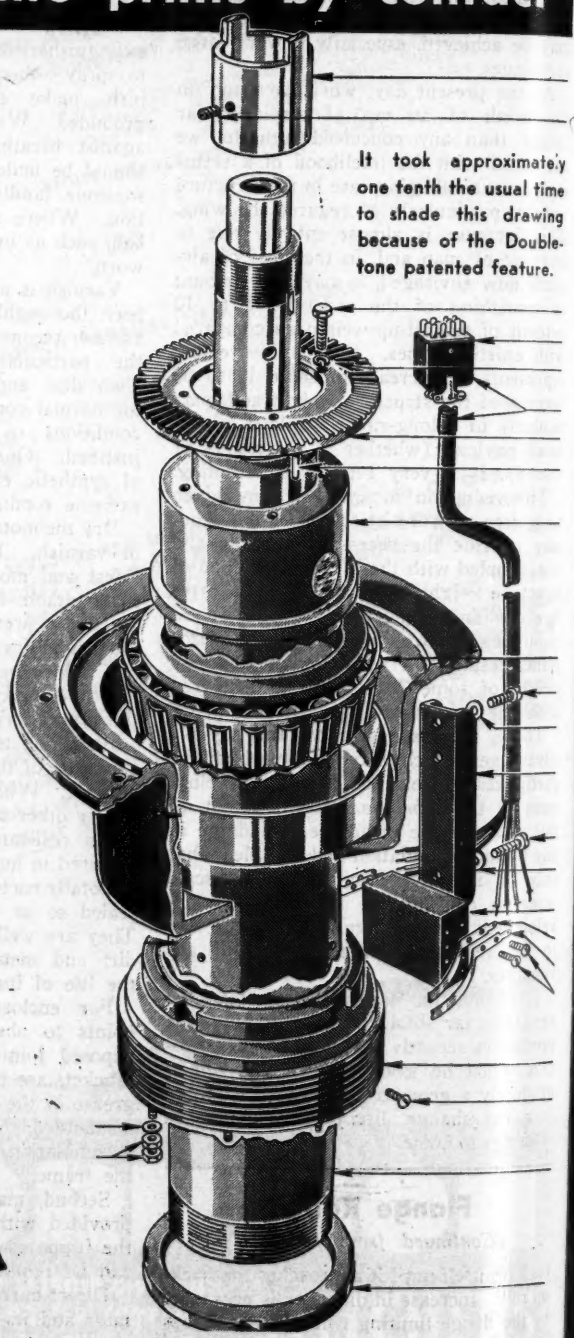

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the general maintenance problem. The armature is the heart of the direct-current motor. Through it flows the main-line current, and if the machine is overloaded the armature is first to show distress.

When dismantling a d.c. motor for periodic overhaul the following points should be observed. Do not roll armature; a coil may be injured or the steel banding wire may be nicked. Support or lift the armature only by its shaft if possible. Never allow weight of armature to rest on the commutator or coils. Inspect coils carefully to see that they are tight and where necessary replace the wedges. Replace any bands that may be loose.

As far as possible duplicate the banding originally furnished by manufacturer. Do not change material or diameter of the banding wire, nor width or position of band. Increasing band width may cause heavy currents sufficient to overheat and melt the solder.

Only experienced workmen should tighten loose commutators. If commutator bars are tight they will give out a clear bell-like ring when tapped lightly with a small hammer. If the commutator does not ring, but gives out a flat sound when struck, the front "V" should be tightened.

Exposed portion of the front mica "V" ring is normally a catch-all for oil and dirt. This section should be cleaned and protected with a layer of surgical tape and twine to prevent flashovers and breakdown to ground. Red synthetic enamel will give a smooth finish, resistant to oil and carbon dust.

Check brush rigging carefully. Most brush holders in use today are box type and should be replaced when the inside broached section is worn.

Brushes must fit properly, not so tightly as to stick, and not so loosely as to shift position when running. Make sure that the grade used is correct, using the advice of the manufacturer. Make sure that the fit of brush on commutator extends across the face of brush.

Spring tension on the brushes should be uniform to prevent selective action. Correct pressure will vary with design and adjustments should follow the manufacturer's recommendation. The brushes should be staggered to prevent grooving of the commutator. Brush shunts should be kept tight and free from corrosion so that current will be uniformly distributed to the brushes. Under bad conditions of corrosive atmosphere the shunts can be protected by dipping in melted paraffin or in synthetic red enamel or by covering with woven cotton tubing.

Resurfacing of the commutator should be done in a lathe, or with a grinding rig. As it is impossible to obtain a true surface with a hand stone, it should be used only as an emergency. Practically all up-to-date d.c. machines have undercut mica in the commutators. This undercutting should be kept $\frac{1}{32}$ in. deep.

A gearmotor is a self-contained drive made up of a ball-bearing motor and a speed-reducing gear unit. It is designed to take advantage of the electrical efficiency of the high-speed motor and the transmission efficiency of properly designed gears.

Suggestions already given apply to oil supply reservoir in the gear unit. Front end motor bearings are generally grease-lubricated and require the same attention as in standard ball-bearing motors. Rear bearings, gear box bearings, and the gears themselves are almost always splash-lubricated from the same oil supply reservoir in the gear unit lower section. Oil seals at each bearing prevent leakage into the windings and out along the shaft. Precision cut gears demand carefully selected lubricating oils. Use only top-grade oils of the specified viscosity.

Contact areas on gear teeth are relatively small, and pressures relatively high. It is essential to provide a film of lubricant sufficient to withstand the localized contact pressure. The peripheral speed of gears governs the contact period during which the film must withstand pressure. When speeds are high, the time is short, loads are light, and a rather light-bodied oil can be used. When speeds are low and loads heavy, contact time is considerably longer and a heavier oil should be used.

See that the oil level marked for each gearmeter unit is maintained. For normal operating conditions, drain the oil reservoir in lower section of gear case at overhaul and fill with new oil.

Airpower Can Mean Security

(*Continued from page* 109)

priations in the United States for our own program.

At that time we had an under-nourished government facility in NACA, insufficient Army and Navy evaluation laboratories, and a lack of money for industry's development contracts. That policy held in the United States until about 1939.

There has been ample testimony on the unrealistic procurement policies of the government with respect to aircraft development, extending through the late 1930's.

Faced with a certain European war, it still took first French and then, nearly a year later, British money to underwrite sufficient production for American aircraft factories so that the industry was able to accumulate personnel and facilities for the start on its subsequent expansion program.

Early in 1939, for instance, Pratt & Whitney's aircraft engine facilities were faced with a lay-off of approximately one-fifth of their total skilled employees, with war definitely just over the horizon. It was the French purchases which put those employees back to work, added to them, and formed the start for the program which followed.

On Feb. 20, 1939, Gen. Arnold addressed the National Aviation Forum, stating that the Air Corps' goal was to obtain 5,500 planes before July, 1941. In April, 1939, he appeared before Congress to explain his proposed program. The House cut this program for 5,500 units to 59 units and the Senate provided funds for 375 planes. It was not until April, 1940—after the fall of Norway and with the world aflame

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—that funds were made available for this original program formulated a year previously. This program then measured up as only a mere fraction of Germany's air strength.

The truth of the matter is that America had become a second rate power in the air, except for the unsurpassed job being done by American transports in civil aviation and in the field of private flying. It was in this condition that we faced a certain world holocaust of war.

We probably had more private aircraft at that time than any nation in the world. We had the best transports. But our fighting planes, as was shown, were not then comparable to the best products of our potential enemies. We had drifted into a second rate place because insufficient funds had been provided for our military services to match the degree of development carried on by the totalitarian countries.

There is no need to recount the industrial and technical miracles in the ensuing period that have been wrought with the intelligent cooperation of the armed services. These have brought us where we are today. However, the lesson of France should show us clearly that we cannot stay where we now are without realistic action based on a full consideration of the factors that have brought us here. These must be evaluated and made effective if we are to remain a first rate air power.

For instance, it is not known generally that development of the Boeing B-17 *Flying Fortress*, one of the world's greatest fighting machines, was first begun in 1934. It had required an expenditure of over 4,000,000 engineering man-hours between 1934 and 1942—a period of eight years—to bring it to the high state of efficiency as a fighting machine that was necessary to start the unprecedented operation of daylight precision bombing against heavily defended Europe.

The Consolidated B-24 *Liberator*, an equally successful heavy bomber, was started in January, 1939, and having available the service experience of the *Fortress*, became a potent fighting machine shortly thereafter. Our medium bombers grew out of an Army-sponsored competition about 1938 and were largely developed by French and British purchases before our entry into the war.

Even under most ideal conditions, an airplane does not become a good, service-tested machine in less than two to three years. As everyone familiar with the war knows, airplanes are constantly being modified on the production lines. The Curtiss P-40, an early type American World War II fighter, has run through its model series of major modifications clear up to the letter "Q", indicating the necessity for its continued development.

There have been no new aviation engines brought out in service in this war that were not started before the European war.

For example, the present power plant for the new Boeing B-29 *Superfortress* and the Navy's great flying boat, the Martin JRM-1 *Mars*—the Wright 3350 engine—was begun in 1936 and is only now becoming an accepted, service-tested engine, all at a cost of something more than $13,000,000. In the liquid-cooled aviation engine field, the Allison was started in 1930 and is still undergoing development into higher powers.

In the important field of accessories, the Sperry automatic pilot was first recognized internationally in 1913. From then to 1932, the development had cost an estimated $1,000,000. Not until 1932 was the first commercial order for 42 received by Sperry. In 1935, it was not yet considered of value as a military development. This is a period of 22 yr. from the first accepted demonstrated model.

Thus it can be shown that literally all of the American air fighting equipment now in action had its origin in the prewar period. Therefore, it is obvious that a nation cannot have time to arm in the air when confronted with a major international crisis.

Unless the principles of air power such as outlined by the Aeronautical Chamber of Commerce are accepted and implemented by a wise policy for continued development, our country cannot be expected to hold its position in world affairs.

Commercial designs will, under the American system, be best developed as in the past, by wise regulations of the CAA, wise policies of the CAB, and the enterprise of the commercial airlines and the private owner demand. This system produced the best airplanes for world commerce and personal flying in the prewar

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period and, in a free economy, will continue to do so in the postwar period.

There is, however, a legitimate field for government activity and for private industry, in which each is by nature best adapted for its task. Fundamental research not applicable to specific projects can best be fostered and accomplished in government laboratories such as those at the NACA. Special application of research to particular designs or projects is the legitimate function of private industry with all of its competitive stimulus. This will avoid the mistake made by Germany, by providing a diversification of solutions not readily possible under a totalitarian or government-dominated system. Evaluation of the results of private industry developments can best be accomplished impartially by the Army and the Navy in their respective facilities, such as Wright and Eglin Fields, the Naval Aircraft Factory, and other Navy evaluation centers.

These vital functions in over-all development should never be in conflict, one with the other, if wisely molded into an over-all policy. This will provide America's answer to the competition of other great powers, if it includes the necessary procurement of service-tested quantities of the new models, produced in sufficient volume for operational and tactical use.

This volume can be had only through a research and continuing development program embracing the following points:

1. Present development contracts should not be terminated.
2. Military research, design, and development should be continued on a constructive basis through competitive private industry.
3. A production program for the aircraft industry should be maintained to retain its ability to establish production processes and to permit the air forces to become familiar with the handling of such planes. This would assume that 20 percent of the number of airplanes in the air forces will be replaced annually. That would give the industry, if it knew the size of the postwar air force, a basis for planning.
4. New and advanced models of all types of military aircraft required for a balanced air force should be designed and developed. And quality of the product should be the primary factor in placing orders.

"Grasshopper" Goes To War

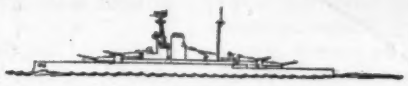
(*Continued from page* 115)

Cub. While the pilot skirted the ridge, he not only saw the tanks but counted them.

During the long compaign south of Rome, the Germans controlled most of the mountain peaks which could otherwise have been used as artillery observation posts, and the liaison planes became doubly important. Enemy gun positions were spotted from the L-4's and serious losses to the Allied armies were prevented.

Some air jeep crews say they don't mind going unarmed and unarmored to

BATTLE-TESTED



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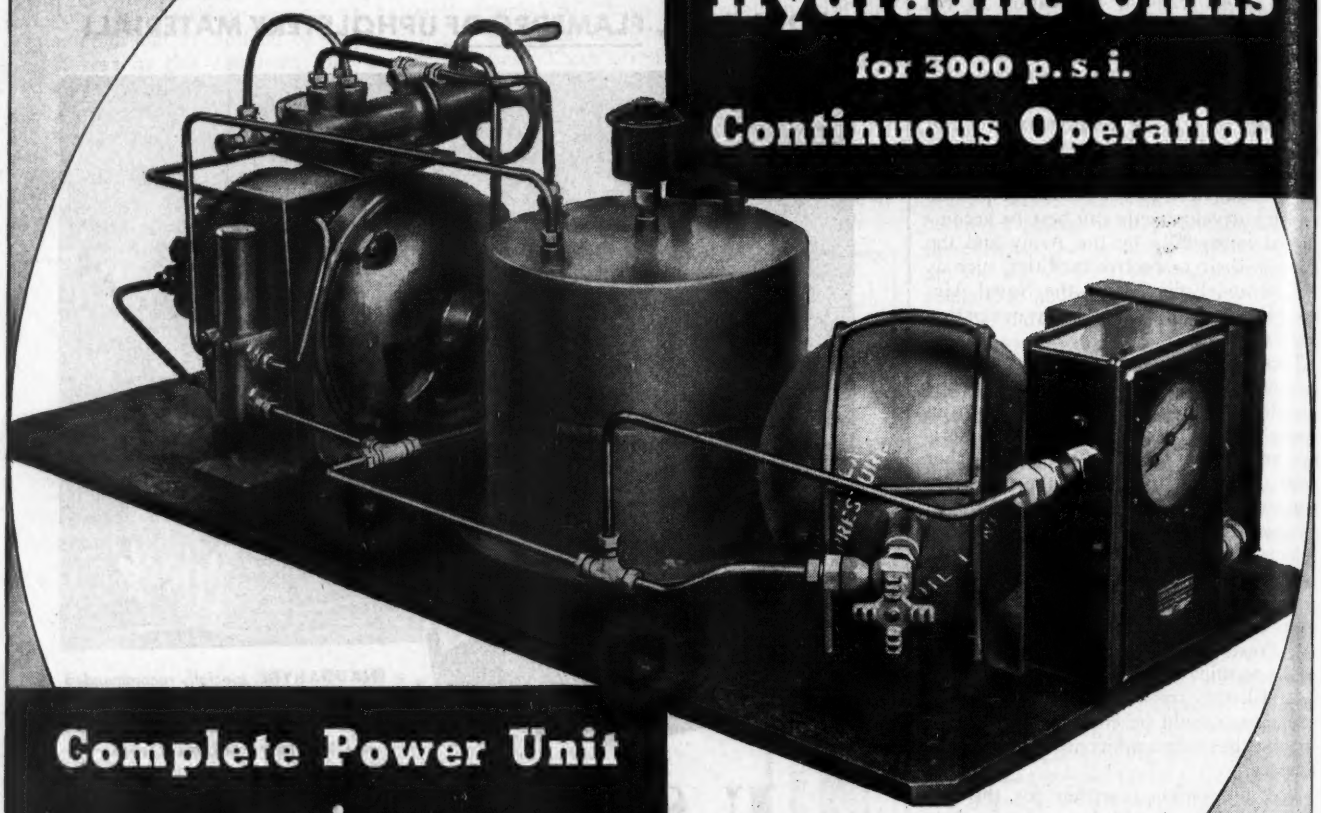

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spy on the enemy from his very firesteps. They have bigger guns at their service than any airplane can carry. One day a *Cub* pilot was flying along when a Nazi machine gun crew opened up on him with tracer bullets. He got even with them in a hurry. In an instant an American field battery had the Nazis position and was pouring shells on them. "Why search the cockpit for something to throw when you can have the best Artillery in the world do the job for you?" the pilot asked.

A report to the Field Artillery Association says that in Italy, observation planes were generally flown at 1,000 to 1,500 ft. altitude, sometimes as high as 2,000 ft. They picked up gun flashes and adjusted on them, by reference to adjacent terrain features.

One observer flew 20 different days between 11 October and 17 November. Longest time in the air for an observer was 5 hr., during which he fired four missions; the shortest trip was 40 min. In Africa, the observer could run out, give an adjustment on the enemy, and be back under camouflage in a few minutes. But in Italy, because of the mountains, extensive scouting became necessary. Sometimes, in 4 or 5 hr., an observer can pick up several targets. Observation is better on a hazy day than on a bright day, because gun flashes show up.

Early in the war, the enemy began firing on observers as soon as they came within range. He soon discovered that giving away his position brought quick shell fire from the observer's artillery. It is the enemy's general practice now to withhold even rifle fire and let the grasshoppers pass. However, this is not strictly the rule, and the observers are often in danger. If observers get the habit of flying the same course day after day, the enemy adjusts on the course, waits for the L-4, and fires heavily at close range. Liaison pilots say the best way to evade ground fire is either to dive and hedge hop or stay up and zigzag. Another evasive measure is night observation, by moonlight, when the light planes are difficult to see. Ground crews guide them back onto base runways with flashlights.

Despite reports to the contrary, enemy fighter planes are effective against liaison planes. If the latter can get into the woods, or in a canyon, or circle under a prominence, for example, it is true that long-turning fighters have trouble getting in shooting range. But otherwise enemy fighters can and do make effective passes at them. To improve their chances of success, fighters attack in pairs. Observers have met this tactic by going in pairs themselves, one plane making observations while the other serves as a lookout, reporting to its partner by radio.

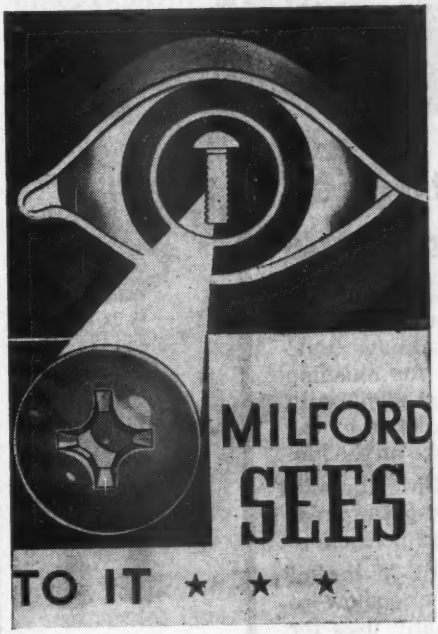
Marooned troops have been supplied by means of parachute-dropping apparatus attached to the *Cubs*. Rations and water cans have been delivered on parachutes made of OD blankets, also useful to the stranded men. Chutes carrying water cans weighing 90 lb. and rations weighing 65 lb., dropped from 400 ft., opened after 100 ft. fall and landed 40 ft. short of destination. Rations are packed in two 105-mm. fiber ammunition cases, on separate chutes. Light fragmentary bomb releasing devices have been fitted to the L-4's, but the dropping kit alters flight characteristics so that the plane must be flown with great care.

Practically all grasshopper pilots have come from the Field Artillery's Department of Air Training at Fort Sill, Okla., one of the Army's newest schools. Training operations started in the summer of 1942. Col. W. Ford, FA, who had been flying private planes for 10 yr., was the first director. Many men from the 74 classes who have flown grasshoppers overseas have been returned to duty at Fort Sill, to add their valuable experience to the curricula.

Training of pilots is in three phases: (1) Qualified artillerymen are given ten weeks of basic flight instruction by the Army Air Forces. (2) They are returned to Fort Sill where they learn special flight maneuvers—precision landings, efficiency takeoffs, cross-wind takeoffs, barrier takeoffs, forward and side slips, slipping turns, power landings, cross-wind landings, tail-high taxiing, one wheel takeoffs, takeoff into climbing turns, contour flying, dragging areas, precision power slips, and fishtails. And (3) they go back into Field Artillery making adjustments on targets from their cockpits, employing the methods learned before they began flight training.

The Artillery has always used elevated fire observation posts, but never accepted

PHILLIPS *Recessed Head* SCREWS



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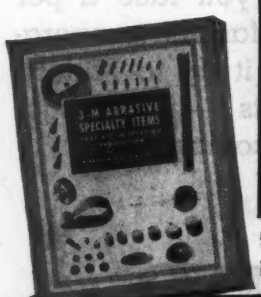

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light aircraft for that purpose until this war. Acceptance of the "grasshoppers" came only after demonstrations by Piper, Taylorcraft, and Aeronca, at their own expense and with their own pilots, during the Louisiana maneuvers in 1941. After extensive training operations, Artillery concentrated on the Piper *Cub*—the Army calls it L-4—for overseas duty. Meantime, Taylorcraft L-2's and Aeronca L-3's were delivered in substantial numbers and are giving very satisfactory service, mostly in this country. Stinson's L-1 was the first Artillery liaison plane; several hundred were delivered in 1939. Stinson L-5 is the main liaison plane of the Air Force, which sometimes does fire control observation for the Artillery. Stinson L-5B is equipped to carry an ambulance litter, and it appears to be in use by both air and ground forces.

Army selected the Piper as its main Air OP plane because, somewhat lighter than any of the others, it affords a slight edge in performance. All are powered with 65-hp. Continental engines, except the two Stinsons, which carry Lycomings.

The contemplated shift to "safety" models does not mean that Piper will go out. The Piper company has several new designs, some in the air and some in advanced engineering stages, incorporating the desired safety characteristics. In fact, Piper has stated that it will produce spin-resisting designs for the postwar private plane market, also that it will license whatever patents are necessary to do so. Two-control feature will be offered if it proves desirable.

Several other light plane manufacturers who have developed safety characteristics will have equal opportunity along with Piper to sell the Artillery. Engineering Research Corp., maker of the *Ercoupe*, and General Aircraft Corp., producer of the *Skyfarer*, were pioneers in the so-called fool-proof airplane field. Taylorcraft, Aeronca, and others, have plans to produce special designs for non-professional pilots. Aircraft for the Ground Forces are procured under GF specifications by the Air Forces, and GF pilots fly them.

The Artillery is not alone in the use of liaison-observation-courier planes. Such craft are also employed by the Air Forces and by Naval aviation for various duties. It is not unlikely that most or all of the armed service branches will use light planes in one way or another. Indeed, there are enthusiastic advocates of military air flivvers who have suggested that whole armies will fly in future, each man a hell's angel on his own.

Confusion in Canada

(Continued from page 170)

Instead, it appears it is to be stripped of its airlines.

In connection with the Yukon service—which has now become "mainline" in character and which TCA is reported to covet—the minister remarked that "the equipment of the company (CPA) was augmented considerably at a time when all other airlines on this continent found it impossible to buy new equipment."

This statement has raised some eyebrows, because the minister naturally knows the circumstances under which the equipment was secured. His own office (Munitions & Supply) had to pass on the requisitions for CPA equipment before they could be forwarded to the Joint Aircraft Committee at Washington (on which the Canadian Government is represented) for final action.

CPA got the planes for the purpose of doing a war job for the United States Army. The craft would not have been available to any line on a commercial basis—and most of them were freighters.

Would it not seem extremely foolish, then, say the eyebrow-raisers, for the government to rip out an air service that holds the key to whatever economic development can be achieved in the Canadian north in postwar years, unless it plans to nationalize all the services?

Particularly bitter were the men who originally pioneered the routes, who went with their component companies to CPA, and who now see their life work being thrown into the discard. They were as vocal as they were bitter.

So, on June 6 last, the minister announced in Parliament the formation of an Air Transport Board, to act as a judiciary and regulatory board and to issue licenses subject to the approval of the Minister of Munitions & Supply.

Hansard, Canada's equivalent of the *Congressional Record*, makes juicy reading these days. Consider this verbal tiff in the House:

Mr. Greene: "But if it is administered under this act it will be very directly under the Minister. In effect, it makes the Minister of Munitions & Supply a dictator in respect to all the airways in Canada, does it not?"

Mr. Howe: "Perhaps so; but who would you suggest should be dictator?"

Although the Minister has insisted that the new board is virtually the same as the Civil Aeronautics Board in the United States, the resemblance ends with the administrative features.

Subject only to appeal to the courts, CAB has almost unlimited powers in administering existing laws, which is quite a bit different from acting "subject to the approval of the minister."

Furthermore, aviation policy in the United States is fixed by Congress. Extensive committee hearings are held and representatives of all sides of every proposal are given a chance to be heard.

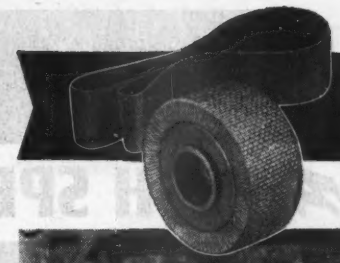
Policy is framed by members of the House and the Senate, not handed down by the Administration, as is done in Canada.

There is no parallel in the U. S. for the provision that "the board shall not issue any license unless and until an operating certificate has been issued by the Minister."

The U. S. board issues a license when the terms of the law have been met. There are no other reservations.

The Minister has, time and again, offered justification for his actions by asserting that he wishes to provide openings for returned flyers to start and operate their own routes.

It would seem rather obvious that air-



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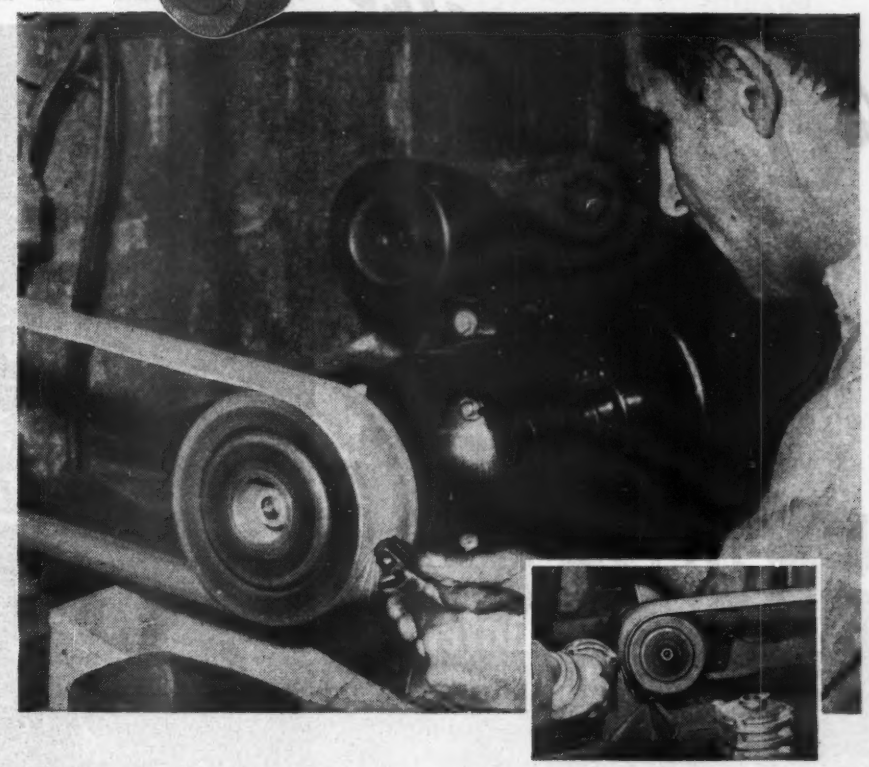

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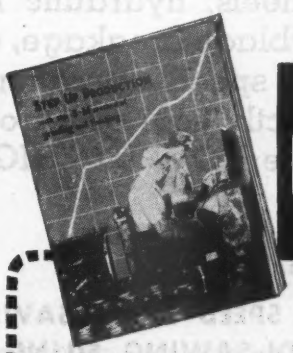

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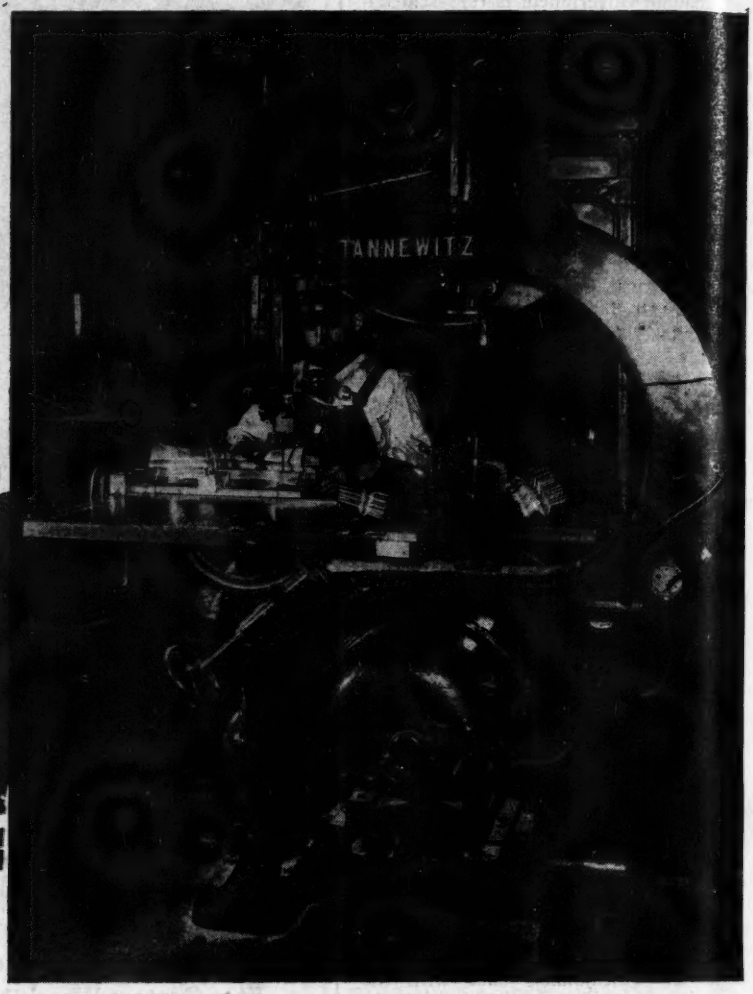

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THE TANNEWITZ WORKS, GRAND RAPIDS, MICH.

men who have been abroad fighting for four or five years would hardly be in a position to scrape up the few hundred thousand dollars necessary to start a small airline.

Private operators point out that the way to provide for returned airmen is to get the routes started *now*, have them operating, ready for expansion when the war is won and Canada can again look northward.

They also point out that there is no profit in starting an air route only to have it seized from them by the government when it becomes of "mainline character."

Canadians point to the bitter lesson learned by Britain in regard to government monopolies. Imperial Airways, government-owned, so disregarded the public that it was operating 80-mph. aircraft at a time when U. S. schedules were being flown by 200-mph. airliners.

In Canada, too, traffic in the postwar years will go to those airlines supplying the best service, not necessarily to a Canadian-subsidized line.

TCA is the only Canadian airline which can cross the border into America. But, under international agreement, U. S. airlines have reciprocal privileges. For instance, Toronto-to-New York is flown by both TCA and American Airlines. There is going to be a lot of travel across the border, and wide-awake American operators might easily get the bulk of it.

But internally there seems to be no choice. From the looks of things, it is Trans-Canada or nothing from now on.

A bitter pill to swallow for a country founded on the principles of freedom of enterprise and competition—but as long as present conditions prevail, that is the way it will be.

Trans-Canada Air Lines is a well-run airline, and it has brought many benefits to Canada. But it has also brought jealousies and selfishness which it has the power (being government owned) to enforce on competitors.

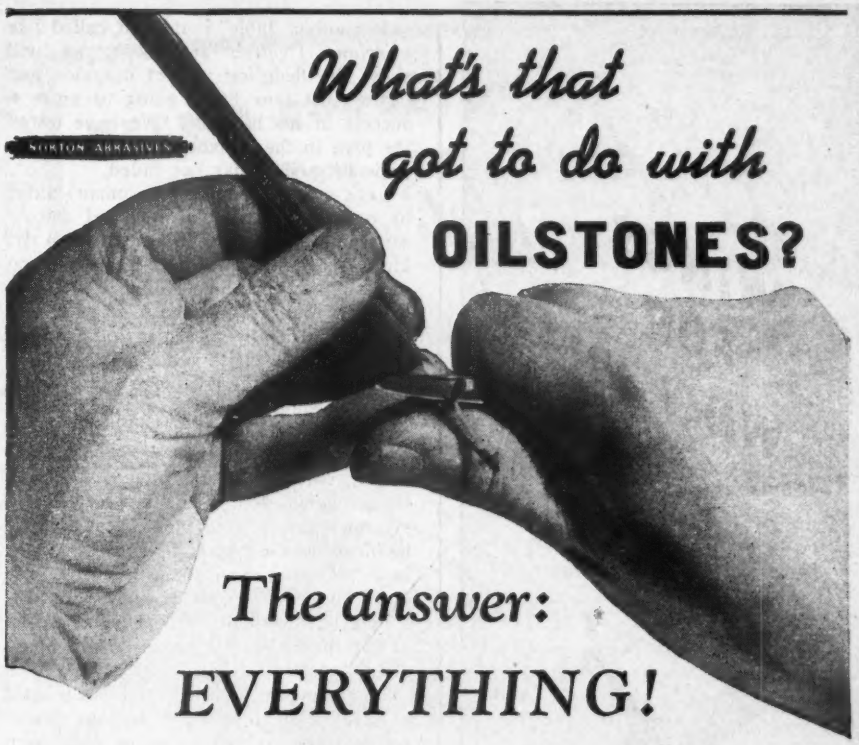
Certainly this is a situation which offers an interesting object lesson on the pros and cons of government instruments.

Merchandising Planes

(Continued from page 117)

factor in postwar planning. No one can predict with certainty how closely personal flying after this war will parallel automotive development after World War I. But we do know that few people except Henry Ford and a few others saw what was coming and acted accordingly. What those automobile pioneers did in establishing distributors and dealers in thousands of communities, American men and women can do again—with our help.

Successful airplane merchandising, like any other job, is somewhat of a special art. But it can be easily acquired through close personal guidance and frequent dealers' meetings at which concrete, practical plans and promotions will be discussed and followed up. We are not just going to help set up an airport, sell someone a plan, and then let him try to avigate blindly.



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The same goes for machine cutters. To do the best work quickly, the edge must be an unbroken straight line; no saw teeth—no matter how microscopic—to bear the full load, break off, rub and generate heat.

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Have one of our field men or your Industrial Distributor's Representative show you the many special shapes and sizes to fit your own particular operations.

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THIS BOOKLET, "Hand Stoned Cutting Tools," will prove an eye-opener for everyone interested in tool improvement and conservation. How many copies can you use?

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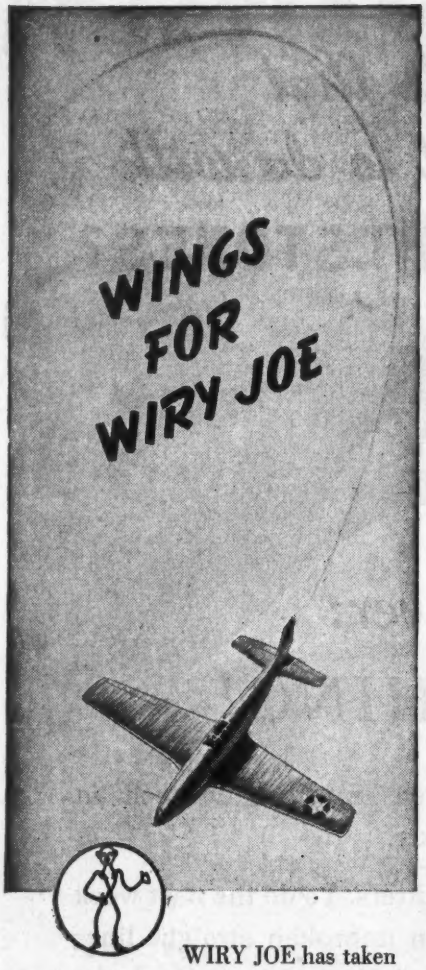

WIRY JOE has taken to the air! Long famous as the largest independent manufacturer of automotive replacement wiring, Wiry Joe today is an important source of aviation wire and cable.

Produced under the Dostam method of manufacture, to assure uniformity ... dependability ... high efficiency ... long life, Wiry Joe electrical wire and cable for aircraft conforms fully with rigid Army and Navy specifications.

Inquiries concerning electrical wire and cable for any type of service—aviation, marine, automotive, industrial—will receive prompt answer.

In another "bible" in its field, called *The Airplane Dealer's Handbook*, we will show the fledgling airport operator and dealer just how he is going to make a success of his business. We have tested the plan in the crucible of hard-won experience, and it has not failed.

Let's say that a man (or woman) aided by us in locating an airport and getting set up in business, teaches another to fly. He has acquired his first light plane on an easily arranged financial basis. It helps to know that it's good business to deduct the cost of such flying instruction from the price of a new plane which the graduate student is probably itching to buy. A year, however, should be the limit in which the student may take advantage of this offer.

Such an arrangement, as business expands, requires bookkeeping. We have the answer to that. A model bookkeeping system, again proved by experience, will be furnished the dealer. He will be taught how to use it, and forms will be provided to get him started right. It is a simple but complete system—a consensus of the methods used by successful operators.

For example, Glen T. Clark, with little more of a start than the average dealer we envisage, did what can be done over again, even starting from scratch. He started flying in 1927. He had been a carpenter's assistant, house painter, and furniture repairman. After joining the U. S. Army, he had transferred to the Air Corps and become a pilot. After his discharge, he went into partnership with another airman and operated a profitable flying school in Honolulu.

Clark returned to his home in Charleston, W. Va., to start what he believes is the first private seaplane base in this country. He purchased an Aeronca seaplane to start with, but business soon became so good, he added more planes of the same make—all of them on floats.

At Clark's highest point of normal peacetime operations, he was flying 12 seaplanes from dawn to dusk, and handling 50 to 60 students. He reports that in his best year he grossed $160,000 and had 26 persons working for him. When peace comes, he is going to reestablish his business, based on the same kind of practical experience we are providing homecoming veterans and former war workers.

Financial support is, naturally, of utmost importance to a new dealer. We will help show the budding operator how to get the necessary financial backing, both from local and national sources; the "paper" for his planes and hangar will be facilitated. Instead of waiting for approval from some distant office, a dealer, can, on new Aeronca planes, recommend the buyer to the finance company and approve the deal himself right on the spot.

Dealers' commissions on aircraft sales, we believe, should be collected at the source immediately upon completion of the sale by deducting them from the purchase price before the balance is remitted to the distributor.

While principal sources of revenue will naturally be from aircraft sales, student instruction, and hangar rental, there are many other sources which should not be overlooked, and which we will call to all dealers' attention. The light plane can, for example, often serve in emergencies. Patients may be rushed to cities from outlying communities for specialized care; doctors, nurses, and serums may be transported equally fast to remote regions.

Every source of revenue, however, requires constant promotion, especially when the dealer first opens his business. We are urging them all to become an integral part of the community life. The mayor, other local civic leaders, newspaper editors, and radio station operators should be invited to the new airport and given flights. Nor should the women and youngsters be overlooked; they both wield enormous influence. Details on methods of cooperating with both newspapers and radio stations are provided, for publicity is essential to continued success.

Experience shows that airports still attract many people. We are urging that our dealers' airports be strategically located with easy accessibility always in mind. But one must do more than that. Still more people must be induced to come. For example, stores are frequently looking for interesting displays. A plane can be loaned to a prominent, well-situated store. The distributor will cooperate, for he has used this publicity method himself and knows the answers. Neat, easily-made placards will point out the salient and interesting factors in the display. A pretty girl—and there will be plenty of them anxious to add to their charms by flying—should "dress" the window display and hand out literature. Both men's and women's aviation fashions are natural tie-ups for the store's benefit as well as the dealer's.

Through such methods, and others on which we are furnishing know-how, three men added materially to a successful business. Ed Youngs, K. E. Neville, and A. F. Lytle decided several years ago that they could sell light planes. Their initial asset consisted of one partially-paid-for plane. As the Dakota Aviation Co., they trained students, hopped passengers, and did charter work. But they had soon progressed far enough to handle the sales distribution for Aeronca planes in certain areas of North and South Dakota.

All three men worked their territory and, one year later, they had jumped their sales 100 percent. They continued building their business by training more students, repairing airplanes, carrying passengers, and steadily increasing their sales. Mr. Neville especially remembers the day he flew his first Aeronca. One month later, he had sold his first of the same make.

The three men had a modest beginning, like many others, but they proved to themselves and their community that light planes build a successful business when based on the kind of practical experience we are making available.

The airplane dealers' handbook provides explicit data on refreshment stands as revenue producers, how to devise and distribute brochures and other advertising material, and how to get the best results from direct mail campaigns. The data are illustrated with examples that have proved themselves. We are purchasing match covers, auto license plaques, and

lapel wing pins in large quantities, thereby making a saving which we will pass on to the dealers who may acquire their own supply in any quantity.

The average man doesn't think he is an orator. But he doesn't have to be one to give interesting, informal talks before chambers of commerce, granges, luncheon clubs, school assemblies, veterans' organizations, fraternal groups, and other associations. With the practical help we give him, the airport manager and dealer will make a distinctly creditable showing. Sample scripts will be furnished, basic notes from which he can prepare his own talk will be provided, and other practical hints will be sent him.

When the local movie theatre is showing any picture with an aviation angle, the alert movie manager will be delighted to have a plane or exhibit from the airport to help advertise his attraction.

We are not advising "hippodrome" tactics or out-moded air circuses. Aviation has outgrown such manifestations of its earlier, romantically raw days. But spring showings or exhibitions of new models, tied up with new seasonal fashions, provide excellent publicity and advertising.

We are pointing out that there should be no charge for such exhibitions, that they should be made the occasion for distribution of literature, pins, photo postcards, match covers, disks or windshield stickers for cars. Incidentally, it is always good policy to give an advance showing to the press and radio people with a bit of refreshment thrown in.

It is not going to be long before the one-man or one-woman show at the new or revitalized airport will have to be expanded, with more help added. Carefully considered and proved advice is necessary at such a point—and we are providing it.

The first additional person to hire may well be a partially disabled veteran who can do great good on the ground while the dealer and airport manager is flying. This helper can fuel planes, help roll them into the hangar, keep the equipment clean and bright, answer the telephone, and keep visitors happy, encouraging them to stay around if the boss is aloft.

Probably the next employee should be the second pilot. He may well prove to be a buddy from the service, or one of the boys—or girls—who may have been among the first students to be licensed. Such a second pilot will do much to relieve the strain on the dealer and double the rate at which students and others may be accommodated.

Local schools provide excellent contacts for the personal airplane dealer. Classes may be interested in writing essays on aviation, with the writers of the best to be given free rides. Children, like women, wield an immense amount of influence and should never be forgotten in the promotion carried on by the airport operator.

Boys Scouts and Girl Scouts often may be used at the airport to police crowds at advance showings of models. The youngsters will back you to the limit, especially if they are rewarded by hops and a feeling that they are welcome to browse about the airfield when weekends and summer vacations permit. Local troops of Air Scouts for boys and Wing Scouts for

Photo: Courtesy Air Cargo Development Section — Pennsylvania-Central Airlines

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PORTABLE, inclined pilers like the one illustrated above save a lot of time and effort—handling and stacking packages, bales, bundles, boxes—in the plant or warehouse, at the airport, around the shipping platform, unloading and loading cars, trucks, boats, transport planes.

Handibelt Pilers are available in a wide variety of sizes and styles as required by various commodities. The unit illustrated has an adjustable boom which is easily extended over piles or into car or truck; the boom is clear of all supporting obstructions and is adjustable up to 7½, 8½ and 9½ feet. It handles individual items up to 100 lbs. Other Standard Pilers elevate and stack up to 30 feet. Individual horizontal conveyor sections can also be furnished; these are particularly useful for shipside loading and unloading.

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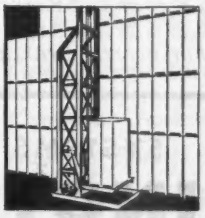
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girls should be organized and sponsored with aid rendered through the over-all plan.

The finest sales plan will not be successful unless one has the proper product to sell. Furthermore, one should have airplanes that will meet the requirements of almost every prospective customer. Aeronca knows what the demands of the postwar personal airplane pilot will be and has designed airplanes to meet them. We will provide a complete line of airplanes for our dealers and our future dealers to handle.

We have designed, built, and are now flying a two-place tandem, high-wing, monoplane which we feel will be unexcelled for flight instruction and general utility flying. For farmers, ranchers, prospectors, miners, and others who need a general utility airplane, the dealers will be able to fulfill their needs with this airplane.

Many people prefer a side-by-side airplane to the tandem type. To satisfy this demand, we offer the twin sister to the first plane just described. The principal difference will be fuselage and seating arrangement. Otherwise it will be identical with our tandem.

The wings, tail surfaces, landing gear, cowling, engine—in short, everything possible—will be interchangeable. This, of course, is a tremendous advantage to the operator because it cuts in half the number of parts he has to carry in his stockroom. It also facilitates ordering of parts, and it lowers the cost of both airplanes because it increases the volume of component parts.

For the pilot who wants a trim, high-grade airplane that will cruise at comparatively high speeds, we will offer an all-metal, low-wing, cabin monoplane with retractable landing gear. This plane, too, has been flying for some months and is receiving a thorough testing so it will be a proven product when Uncle Sam says we can go into production. It has slots, flaps, and spoilers, enabling it to cruise fast and land slowly.

Many people will want a four-place airplane so they can take the whole family flying. We have that, too, in the works.

These planes are, we hope, but the beginning. Just as our dealers and distributors must always be alert to new trends, so the company intends to keep its engineering and sales staffs constantly busy so that Aeronca can give its distributors and dealers the support to which they are entitled.

Automatic Riveting

(*Continued from page* 141)

clips alone are often sufficient to hold the parts in location.

Large panels and many small ones, however, often require no fixture. In some cases, a template pierced for all rivet holes is clecoed to the piece through drilled match-holes. Spraying with quickdrying liquid or dye through remaining holes locates positions. When the assembly reaches the pierce-rivet machine, each spot is brought in succession under a

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light beam focused on the tip of the punch, locating the work with ample accuracy.

Where machine operators are experienced, holes are often located by eye only, eliminating even spray markings. Another method of locating is to apply a spacer block over stripper, as in Fig. 7. The block edge rests against the adjacent rivet just driven and gives a perfectly uniform rivet spacing without any marking or fixture.

When the procedures here outlined are compared with those in which large and expensive drilling fixtures are employed, separate dimpling is needed, and considerable hole burring is required (perhaps followed by hand insertion of rivets and hand driving) it is easy to understand how it is possible in many cases to reduce the assembly time per piece as much as 90 percent.

Motor Controllers

(*Continued from page* 145)

to the *start* position. This action energizes auxiliary relay No. 1, one contact of which, marked *A*, closes the circuit to its own coil through the *stop* push-button, establishing a holding circuit. The other contact of relay No. 1, marked *B*, also closes and prepares the circuit to the *run* contactor for carrying current when pilot pushes the double-throw switch to *run*. The *start* contactor coil is also energized and closes the motor circuit through the starting resistance, and the motor accelerates.

When the motor is nearly up to speed, starting current is greatly reduced. Enough voltage appears across the coil of auxiliary relay No. 2 to pick it up, completing the circuit to ignition transformer, and causing the indicating light to glow. Normally, as the motor comes up to speed, the oil pump will prime and develop oil pressure to the blower bearings. This oil pressure closes the contacts of an oil pressure switch which is located in the oil line. When this occurs, the *low pressure* indicating light goes out because one set of contacts open. The other contacts close and, through auxiliary relay No. 1 contacts *A* and the *stop* push-button, prepare a holding circuit for the *run* contactor when closed.

Now the pilot pushes the heater panel switch to the *run* position and, through contacts *B* of auxiliary relay No. 1, energizes the *run* contactor, which shorts out the starting resistance, and the motor now runs at full voltage. Of course, when the pilot switches from *start* to *run*, he opens the *start* contactor coil, dropping it out of circuit. The operating switch, now released, returns to neutral or open position by spring action, and *run* contactor is held in through *A* contact of relay No. 1 and a pressure switch contact.

Control circuit is connected through thermostat contacts so that if any one opens, the motor is shut down. This shuts off the fuel pump and ignition.

The equipment can be shut down by pushing *stop* button, breaking circuit to the *run* contactor. If oil pressure fails, the oil pressure switch to the run contactor opens, shutting down the equipment, and simultaneously the other pair of pressure switches close, showing by indicating light that the cause for shut down is low oil pressure.

Automatic Control

When automatic control was first proposed, adaptation of existing equipment was attempted. This resulted in a control which weighed 42 lb. and contained none of the special features later incorporated. It was therefore decided to design a completely new assembly of recently available aircraft devices.

The first system proposed, used the essential idea of the manual control, but incorporated a counter emf. relay which automatically transferred control from *start* to *run*. The counter emf. relay has been extensively used in industrial applications, and, as can be seen in Fig. 2, its principle is simple. When the *start* contactor closes, current flows through the motor starting resistance.

As the motor is at a standstill, the only voltage which appears across it is the drop due to internal resistance. This, however, is very small compared to the starting resistance, so most of the total voltage across the circuit (27.5 v.) appears across the starting resistance. The size of this resistor, therefore, determines the initial inrush current. As the motor begins to revolve, it generates a voltage in opposition (counter emf.) to the bus voltage. This counter emf. will increase as the motor accelerates, and the current through the circuit will consequently decrease, resulting also in a decrease in voltage drop across starting resistance.

However, the voltage across the motor increases by the same amount, because the sum of the two voltage drops must always equal the bus voltage, which is constant at 27.5 v. If the control took no further action, the motor would eventually level off at constant speed. However, the counter emf. relay coil is set for a definite pick up voltage, and will close the relay whenever this voltage appears across the motor. When this relay closes, it energizes the *run* contactor, which closes and shunts the starting resistor. This operation places full bus voltage across the motor which continues to accelerate to full speed.

During the design period, two additional components appeared in the installation. A radio noise filter and a separate electric motor driven oil pump for priming. These devices imposed additional requirements for arrangement and control.

The final controller, as built, is shown, with the major components identified, in photograph.

In the main control box is a radio noise filter to suppress radio interference generated by the main motor. The control is enclosed in a welded sheet-aluminum case fitted with studs and an AN connection for easy installation and service. The cockpit unit is fitted with control wires and an AN connector to further facilitate installation. Inspection of the cockpit unit can be made by removing the two holding screws and pushing the box cover back on the wires.

Inside the main control box cover is a

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"On my first tour through one of Bell Aircraft's assembly plants, I saw thousands of Bell employees performing tasks which before Pearl Harbor would have seemed as much of a fantastic dream as was 'Sir Boss's' in Mark Twain's book.

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"I saw hundreds of planes traveling slowly down numerous production lines. From their embryonic stage, they were gradually transformed into air weapons bristling with fire power — each ship armed with four 50 caliber machine guns and a cannon that spews out one hundred and fifty 37 mm. shells a minute.

"Even more impressive than seeing housewives, ministers, and bank clerks using tools with the skill of a New England tool maker, were the systematic methods of production which utilize every working hour and eliminate any possible waste.

"At Bell Aircraft, Victory is being speeded by advanced ideas in military aircraft, developments which are helping to accelerate the advance of the science of aeronautics.

"And when the day of victory comes, look to Bell Aircraft to be one of the pioneers to bring to our daily lives the advancements and improvements in material goods which will be one of the gains from fighting and winning a grim and bloody war."

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detailed diagram made up of a schematic as well as a wiring diagram for the guidance of maintenance men. An instruction book contains the operational details, trouble-shooting tips, and directions for ordering replacement parts.

Operation of the controller is explained in Fig. 3. Main circuit breaker *CB* 1 is automatically reset. Control circuits are protected from short circuit by manual reset circuit breaker *CB* 2. Closing circuit *CB* 2, provides control power.

The pilot now presses the *start* button which energizes relay *CR* 1 through the *stop* button, heater thermostats, and through the *time open* contacts of the thermal timing relay, *TR*. One contact of relay *CR* 1 maintains a circuit around the *start* button and seals in its own coil. Another contact on control relay *CR* 1 energizes the ignition transformer from the 400-cycle supply.

A third contact of relay *CR* 1 energizes the lower half of the diagram, including the fuel pump and primer motor. The circuit to the primer motor is completed through relay contacts *AR*, or the oil pressure switch and relay *CR* 2, all three being normally closed. The operating heater of thermal timing relay *TR* is also energized at this time.

As soon as oil pressure builds up sufficiently (either from the operation of the primer pump or the mechanical pump on the blower), the normally closed contacts of the oil pressure switch open, preparing to stop timer operation and primer motor as soon as the main motor is on full voltage. Simultaneously, the open oil pressure switch contacts close, energizing control relay *CR* 2. The normally open contacts of control relay *CR* 2 maintain the circuit to the *CR* 2 coil, while normally closed contacts of *CR* 2 relay open, and stop the primer pump motor.

The third contact of control relay CR 1 also energizes an accelerating contactor (often called starting contactor), whose contacts apply reduced voltage to the motor because of the accelerating resistor. This resistor allows approximately 250 per cent of rated motor armature current to flow. As described before, when the motor is at standstill, the voltage drop across the armature is low, the drop across the accelerating relay is also low, while drop across the accelerating resistor is high.

As the armature revolves and accelerates, the counter emf. applied to the relay coil *AR* increases. An adjustable resistor *A* is connected in series with *AR* relay coil so that pickup voltage of relay *AR* can be adjusted. Thus, as the motor accelerates, voltage increases to pick up value, and relay *AR* closes. One set of relay *AR* contacts closes to energize main contactor coil *M*, applying full voltage to the motor, shunting accelerating contactor and accelerating resistor.

A second set of contacts on relay *AR* energizes the cockpit unit light, indicating that motor is running with full voltage.

Third contacts on relay *AR* open, and, provided the oil pressure switch has sufficient pressure, de-energize timing relay *TR* heater so that *TR* will cease timing.

If accelerating relay *AR* refuses to close because of an over-loaded or stalled motor, the timing relay operating heater gradually heats a bimetallic strip until the contact marked *TO* opens. This interrupts the circuit to *CR* 1 control relay coil, de-energizing the relay which opens and de-energizes the entire control circuit and power contactors, except for reset heater on timing relay, which is then energized through *TR* normally open contact *TC*.

This reset heater, after a time delay, recloses contact *TO* and opens contact *TC*, starting another cycle of operation. Note also that oil pressure switch, *OPS*, in parallel with *AR*, will time out the control, if oil pressure does not appear. This timing relay (1) protects the primer pump motor from re-cycling too often and overheating (the primer motor is only intermittently rated), and (2) prevents overheating and burnout of main motor starting resistor. The double heater in timing relay provides a reset time somewhat longer than trip time. It also serves as a compensator so that timing will be the same, regardless of ambient temperature.

The ignition cut-off switch is a thermally operated device to cut off the ignition transformer as soon as there is flame in the heater combustion chamber.

If at any time during operation the thermostats in the heater system open because of excessive temperature, or if oil pressure fails, the control will shut down the heater motor. Note, however, that although thermostats shut the device off immediately, low oil pressure will cause it to time out because the mechanical oil pump may regain its prime and oil pressure be reestablished while the time delay is acting. If oil pressure reappears, the timing-out action is stopped.

The co-ordinated control, complete in a case, with AN connectors and lead cables, cockpit unit, and radio noise filter, weighs 12 lb. It automatically performs the functions of the manual control, plus operating the primer motor and recycling when necessary. Conditions dangerous to part of the system will shut down the equipment. Power short circuits are broken by a circuit breaker which automatically resets, while control system short circuits are opened by a hand reset breaker in the cockpit unit, accessible to the pilot at all times.

By subcontracting complete controls, the aircraft manufacturer obtains the use of the manufacturing and engineering know-how of the electrical industry. Furthermore, since these controllers are ready to install as a unit, the electrical mechanic is in the plane only long enough to mount the box and make the connections.

The principle of designing controllers around components specifically developed for control systems is technically and economically sound. It is believed that such co-ordinated control will result in a saving of weight, space, and installation time, require less maintenance, and give more reliable operation. Also, by eliminating multitudinous switches, levers, knobs, and instruction plates, automatic control of this type will relieve the pilot's burden and make for easier and safer flying.

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Takeoff Analysis

(Continued from page 138)

through 13 offer a set of typical trim and resistance data as determined in the towing basin from a general test on a resistance model. These data have been used in the example under consideration.

The angles for the free trim condition are obtained from Fig. 10 and the angles for best trim are obtained from Fig. 12.

From the appropriate curves of resistance coefficient Figs. 11 and 13, the values of C_R are obtained for free trim and best trim. Using the constant previously determined, the value of resistance in pounds is obtained:

$$C_R \times 74{,}090 = R \text{ lb.} \qquad (63)$$

From Fig. 3 the values of drag coefficient C_D corresponding to the proper values of trim, may be determined. Values for full ground effect are used throughout. Using the constant previously determined, drag coefficient, C_D, and V^2; the aerodynamic drag in lb. can be computed.

The total resistance is then the water resistance plus the aerodynamic drag, or

$$R + D.$$

In determining the thrust available, Table VI gives a propeller activity factor, AF., of 90. Entering Fig. 5 with this value gives a power factor, P_f, of 0.95. Substituting this value of P_f into equation (28) the power coefficient, C_p, may be computed.

For the example,

$$C_p = \frac{5 \times 10^{10} \times 1200 \times .95}{1 \times (1350)^3 \times (13)^5} = .0625 \qquad (64)$$

and the advance ratio J from equation (30) is:

$$J = \frac{88V}{1350 \times 13} = .005\, V_{mph.} \qquad (65)$$

With C_p and J known, the values of thrust coefficient C_T are obtained from Fig. 6 for a three blade propeller, and tabulated, as illustrated in Table VIII, for the example.

From equation (31) the total thrust, T, in lb. is:

$$T = \frac{.002378 \times (1350)^2\,(13)^4 \times 4 \times 0.9\, C_T}{3600 \times .95} = 130{,}300\, C_T \qquad (66)$$

The values of thrust are plotted against velocity in Fig. 14 for use in the integration.

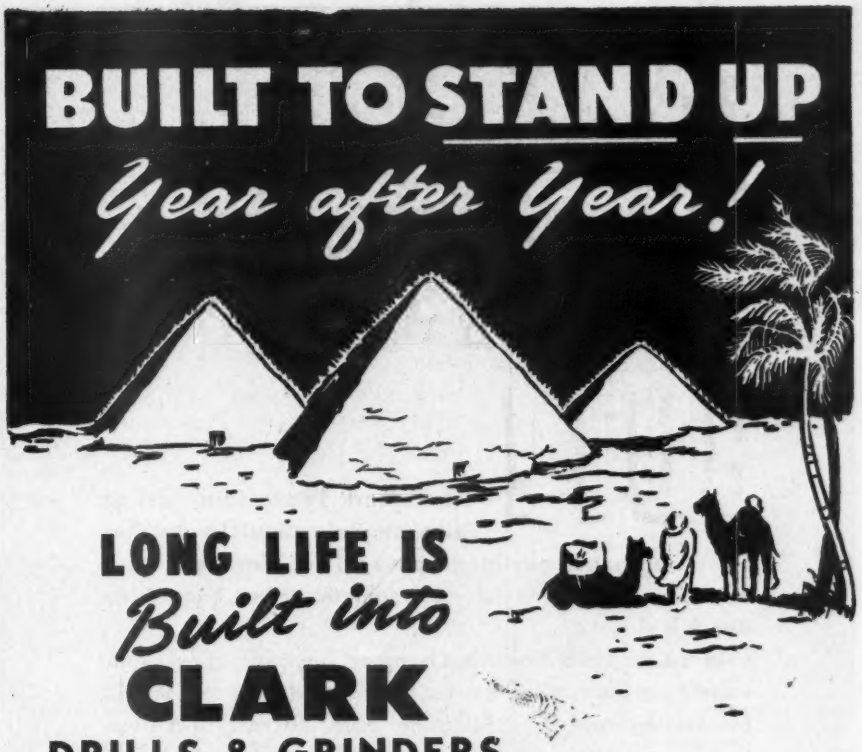
The reciprocal of acceleration is determined by dividing total gross weight by the acceleration due to gravity and the excess thrust, T_e. Excess thrust being the difference between the total thrust, T, and the total resistance, $R + D$.

Equation (8) states that the integral of the reciprocal of the acceleration, $1/a$, between the limits of v_o and v_f gives the takeoff time in seconds. For example the expression for acceleration becomes,

$$\frac{1}{a} = \frac{64{,}000}{32.2 \times T_e} = \frac{1{,}990}{T_e} \qquad (67)$$

Equation (11) gives the expression for takeoff distance which is the reciprocal of the acceleration, $1/a$, times the velocity in feet per second. Integral of this expression between the limits of v_o and v_f will give the distance in feet.

With the tabular data of Table VII de-



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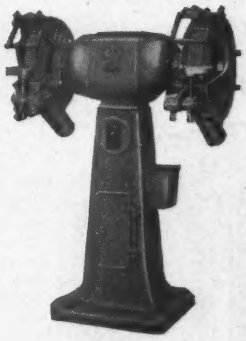

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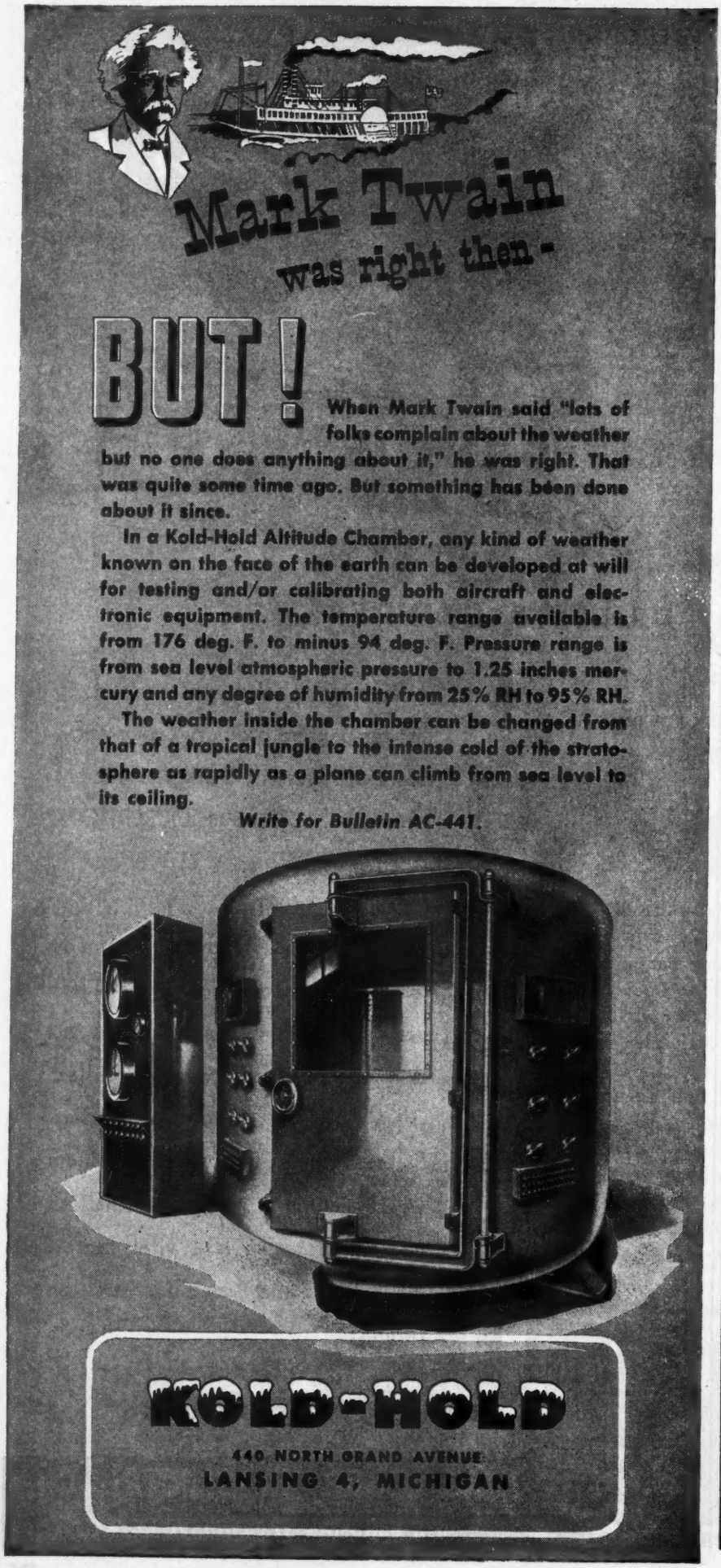
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termined, it is necessary to integrate the values of $1/a$ and v/a between the proper limits to obtain takeoff time and distance. This is most conveniently done as illustrated in Figs. 15 and 16.

In Fig. 15 the values of $1/a$ have been plotted against their respective velocities in miles per hour and, by definition, the area under this curve between the limits of zero velocity and getaway will equal the takeoff time in seconds. By inspection of Fig. 15 it is noted that:

$$1 \text{ sq. in.} = 0.2 \times 20 \times 1.467 = 5.87 \text{ sec.} \quad (68)$$

where the factor 1.467 converts the mph. to fps. to make the integral dimensionally correct.

Therefore, the total square inches under the curve, as determined with a planimeter, is multiplied by the plotting factor to obtain total time:

$$\text{Time} = 8.29 \text{ sq. in.} \; (0.2 \times 20 \times 1.467) = 48.7 \text{ sec.} \quad (69)$$

The same procedure is used to obtain distance, where in Fig. 16,

$$1 \text{ sq. in.} = 20 \times 20 \times 1.467 = 587 \text{ ft.} \quad (70)$$

and,

$$\text{Distance} = 6.52 \text{ sq. in.} \; (20 \times 20 \times 1.467) = 3{,}820 \text{ ft.} \quad (71)$$

It should be pointed out that the value of $1/a$ for zero velocity is determined by using the full value of static thrust in equation (67) for the example:

$$\frac{1}{a} \text{ at } V_0 = \frac{1{,}990}{18{,}600} = .107 \quad (72)$$

Example of Hermann Method

As stated previously in this article the takeoff time and distance may be determined satisfactorily by a strictly graphical construction. This is convenient when a planimeter for determining the $1/a$ and v/a areas is not available.

As illustrated in Fig. 17 for the typical example of Tables VI and VII, the curves of total thrust T of Table VIII and total resistance $R + D$ of Table VII are plotted against velocity in feet per second.

The slope w/g is determined. For convenience in plotting in Fig. 17 it is plotted as $w/4 = 16{,}000$ for the ordinate and $g/4 = 8.05$ ft./sec. for the abscissa. Using this slope, intercepts are laid off from V_0 to V_g between the limits of the thrust and total resistance curves. The takeoff time is the sum of these intercepts, or for the example, time equals 48.3 sec.

Takeoff distance is the sum of the abscissas of each intercept. These values are tabulated in Table IX for the example.

The discrepancy between the integration method and the Hermann graphical method is found to be less than 1 percent for takeoff time. Determination of takeoff distance by the graphical method is found to be 3 percent too high. Normally this accuracy would be acceptable.

Wind Effect on Analysis

In preceding discussions of the theory and analysis of the takeoff regime it was assumed that there was no wind. While this is customary for all computations and for comparing the relative performance of flying boats, it is a condi-

tion that rarely exists in actual practice.

It is, therefore, essential that the effect of wind on the takeoff characteristics be understood, if full scale performance is to be checked against computed values, and a common basis for comparison established.

The effect of a headwind of velocity V_w is shown in Fig. 18. The upper diagram is recognized as the standard takeoff diagram previously detailed in Fig. 1. The lower diagram assumes a wind of velocity V_w has been superimposed. Note that all functions dependent on air speed are displaced to the left because, at zero water speed, the aerodynamics of the airplane, for a speed equal to the wind, are already established.

The thrust and drag curves are displaced bodily to the left by an amount V_w, decreasing the mean thrust available and increasing the mean drag. The hump still occurs at approximately the same water speed; however, since the lift at hump speed is considerably increased, the load on the hull, Δ, is reduced. This results in the mean net thrust being actually increased, as shown in Fig. 18b.

The takeoff time is reduced not only because of greater mean net thrust but also because the airplane is airborne at a lower water speed. The use of flaps which increase the wing incidence, or other lift increasing devices, tends to give the same effect, except that the thrust is not displaced and the drag is increased, usually a considerable amount, by the additional drag of the high lift device.

There are three accepted methods available for computing the effect of wind on takeoff time and distance. The first two methods are empirical and result in large discrepancies when applied to corrections involving takeoff times of over a minute. However, due to the simplicity of the empirical methods and their reasonable degree of accuracy for the majority of cases, their use is quite common.

For all cases where a high degree of accuracy is required, such as establishing guaranteed performance for contractual purposes and accurately estimating overloaded performance characteristics, the third or integrated method is necessary.

The most authoritative and generally accepted of the empirical methods is that presented by Diehl[3] (reproduced in Fig. 19). By entering the chart at the observed ratio of wind velocity to getaway speed, the observed takeoff time is plotted. By following parallel to the nearest lines of the family of curves the takeoff time in a calm is obtained at the origin.

The second empirical method is given by Wood[4] and consists of an equation. This equation was first developed by Jones[5] as,

$$\frac{t_w}{t_o} = \left(1 - \frac{V_w}{V_a}\right) \qquad (73)$$

where t_w is the takeoff time in wind V_w, t_o is the takeoff time in zero wind, and V_a is the takeoff speed. In addition to equation (73) Jones also developed an

[3] Diehl, W. S., "Engineering Aerodynamics," page 503, The Ronald Press Co., 1936.

[4] Wood, K. D., "Technical Aerodynamics," page 237, McGraw-Hill Book Co., 1935.

[5] Jones, E. T., "The Effect of Wind on the Takeoff of Seaplanes," R and M No. 1593, 1934.

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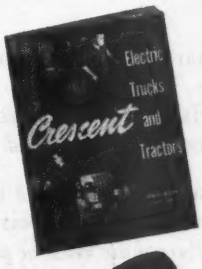

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TABLE VII—Takeoff Computations

(Example)

Engine : x x
BHP./RPM. : 1200/2700
Gear ratio : 2:1
Prop. dia. : 13.0
Prop. AF. : 90

$C_{\Delta_o} = \frac{GW.}{wb^3} = 0.865$

Gross weight, lb. : 64,000
Wing area, sq. ft. : 1600
Beam, ft. : 10.5
Flaps, deg. : 20
C_L@ V_s (0.9 C_L max.) : 1.62

1. C_T	2. V mph.	3. V_2 mph.	4. T deg.	5. C_L*	6. L lb.	7. Δ lb.	8. C_Δ	9. C_R	10. R lb.	11. C_D*	12. D lb.	13. $R+D$ lb.	14. T lb.	15. T_e lb.	16. $1/a$	17. $V_{fps.}/a$
1.0	12.6	159	2.3	.89	580	63,420	.856	.064	4 740	.062	40	4,780	18,000	13,220	.150	2.78
1.2	15.1	228	3.5	1.00	935	63,065	.851	.095	7,040	.066	62	7,102	17,850	10,748	.185	4.09
1.4	17.6	310	4.9	1.14	1,450	62,550	.844	.118	8,740	.071	90	8,830	17,700	8,870	.224	5.78
1.6	20.1	404	6.0	1.24	2,055	61,945	.835	.135	10,000	.075	124	10,124	17,550	7,426	.268	7.90
1.8	22.6	511	6.8	1.32	2,760	61,240	.827	.149	11,040	.080	168	11,208	17,400	6,192	.322	10.65
2.0	25.1	630	7.3	1.36	3,510	60,490	.815	.159	11,780	.083	214	11,994	17,250	5,256	.378	13.90
2.2	27.6	762	8.0	1.43	4,465	59,535	.804	.166	12,300	.088	275	12,575	17,100	4,525	.440	17.80
2.4	30.1	906	9.1	1.53	5,680	58,320	.787	.170	12,600	.096	357	12,957	16,950	3,993	.499	22.00
2.6	32.6	1,063	9.7	1.58	6,880	57,120	.771	.168	12,450	.100	436	12,886	16,800	3,914	.509	24.30
2.8	35.1	1,233	9.0	1.52	7,680	56,320	.759	.164	12,160	.095	481	12,641	16,650	4,009	.496	25.60
3.0	37.6	1,414	8.4	1.47	8,520	55,480	.749	.155	11,500	.090	521	12,021	16,500	4,479	.444	24.50
3.5	43.9	1,930	7.0	1.33	10,520	53,480	.721	.134	9,930	.081	641	10,571	16,050	5,479	.363	23.40
4.0	50.2	2,520	6.2	1.25	12,900	51,100	.690	.120	8,900	.076	785	9,685	15,650	5,965	.333	24.50
4.5	56.5	3,190	5.9	1.23	16,100	47,900	.647	.111	8,230	.075	980	9,210	15,200	5,990	.332	27.50
5.0	62.8	3,940	5.9	1.23	19,870	44,130	.595	.106	7,850	.075	1,210	9,060	14,600	5,540	.359	33.00
5.5	69.0	4,760	6.1	1.24	24,200	39,800	.538	.102	7,560	.076	1,486	9,046	14,150	5,104	.390	39.50
6.0	75.3	5,670	6.1	1.24	28,800	35,200	.476	.099	7,340	.076	1,770	9,110	13,700	4,590	.433	47.80
7.8	98.2	9,650	10.1	1.62	64,000	0	0	0	0	.105	4,150	4,150	11,650	7,500	.266	38.30

$C_T = V_{fps.}/\sqrt{gb}$
$C_\Delta = \Delta/wb^3$
$C_R = R/wb^3$

* Use full ground effect.

$V_{mph.} = C_T \times 12.55$
$C_\Delta = \Delta/74090$
$R = C_R \times 74090$

$L = .00256 C_L S V_2 = C_L V^2 \times 4.10$
$D = .00256 C_D S V_2 = C_D V^2 \times 4.10$
$1/a = GW./gT_e = 1990/T_e$

equation for the correction to takeoff distance due to wind,

$$\frac{S_w}{S_o} = \left(1 - \frac{V_w}{V_o}\right)^2 \qquad (74)$$

where S_w and S_o are takeoff distances in wind V_w and wind zero respectively.

Combining these equations a third equation (75) may be derived which correlates distance with time,

$$\frac{S_w}{S_o} = \left(\frac{t_w}{t_o}\right)^2 \qquad (75)$$

Where a high degree of accuracy is desired, particularly where takeoff time is over a minute, the longer integrated method should be used.

This method is identical to the standard procedure for evaluating the takeoff integral, described earlier in this article and illustrated in Table VII, except for modifications to those functions that are affected by wind. These modifications are illustrated in Table X which is the same as the example illustrated in Table VII, except for the introduction of a 15-mph. headwind.

Note that the modifications to the standard procedure involve carrying two velocities, water speed and air speed which always differ by the amount of wind, and using the correct value of water speed for all hydrodynamic functions and air speed for the related aerodynamic functions. As C_T is a function of water speed it is seen that the airplane takes off at the same air speed as in a zero wind, but water speed or C_T is less.

The $1/a$ and v/a values of Tables X have been plotted in Figs. 20 and 21 and integrated to obtain the new takeoff time and distance. The curves of Table VII are also plotted on Figs. 20 and 21 for direct comparison. Inspection shows the portions of the run most affected by wind. It should be pointed out that the values of $1/a$ and v/a are always plotted against water speed for the integration.

It is obvious that the integrated method is much more accurate than any empirical set of curves or formulas because the incremental effects of wind are applied to the investigation directly in a step-by-step manner.

For example, reviewing the problem that has been presented as a typical case, it is noted from Fig. 15 that the integrated takeoff time in a calm is 48.7 sec., while in a 15-mph. headwind (Fig.

Table IX—Exemplary Determination of Takeoff Distance

Intercept Second	Abscissa Ft. per sec.	Intercept Second	Abscissa Ft. per sec.
1	9.0	26	86.7
2	16.7	27	89.2
3	23.4	28	92.0
4	27.7	29	94.7
5	31.8	30	97.7
6	34.8	31	100.0
7	37.7	32	102.8
8	40.4	33	105.1
9	42.7	34	107.6
10	45.0	35	109.8
11	46.8	36	112.0
12	49.0	37	114.2
13	50.8	38	116.5
14	53.3	39	118.6
15	55.1	40	121.1
16	57.8	41	123.0
17	60.0	42	125.7
18	63.0	43	127.8
19	65.5	44	130.7
20	68.6	45	133.0
21	71.0	46	136.0
22	74.5	47	139.0
23	77.2	48	143.0
24	80.6	48.3	144.0
25	83.3	(1–25)	1265.7
Total:(1–25)	1265.7	Total:(1–48.3)	3935.9 ft.

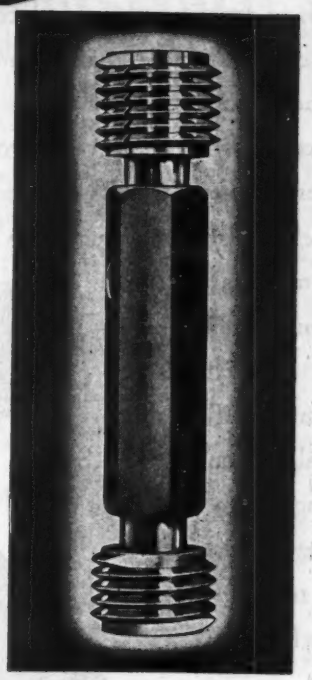

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TABLE X—Takeoff Computations

15 = mph Headwind

(*Example*)

Engine	: xx	Gross weight, lb.	64,000
BHP./RPM.	: 1200/2700	Wing area, sq. ft.	: 1,600
Gear ratio	: 2:1	Beam, ft.	: 10.5
Prop. dia.	: 13.0	Flaps, deg.	: 20
Prop. AF.	: 90	C_L @ V (0.9 C_L max.)	1.62

$C_{\Delta_o} = \frac{GW.}{wb^2} = 0.865$

1. C_V	2. V_k mph.	3. V_o mph.	4. T deg.	5. C_L*	6. L lb.	7. Δ lb.	8. C_Δ	9. C_R	10. R lb.	11. C_D*	12. D lb.	13. $R+D$ lb.	14. T lb.	15. T_o lb.	16. $1/a$	17. $V_k$fps/a
1.0	12.6	27.6	2.4	.90	2,810	61,190	.826	.062	4,590	.063	197	4,787	17,100	12,313	.161	2.98
1.2	15.1	30.1	3.6	1.01	3,750	60,250	.813	.089	6,590	.066	245	6,835	16,950	10,115	.197	4.37
1.4	17.6	32.6	5.1	1.15	5,020	58,980	.796	.107	7,940	.071	310	8,250	16,800	8,550	.233	6.00
1.6	20.1	35.1	6.2	1.25	6,300	57,700	.779	.124	9,200	.076	384	9,584	16,650	7,066	.282	8.31
1.8	22.6	37.6	7.0	1.33	7,710	56,290	.759	.133	9,850	.080	464	10,314	16,500	6,186	.322	10.70
2.0	25.1	40.1	7.6	1.39	9,180	54.820	.740	.143	10,600	.084	555	11,155	16,350	5,195	.383	14.10
2.2	27.6	42.6	8.3	1.46	10,870	53,130	.717	.144	10,690	.090	670	11,360	16,200	4,840	.412	16.60
2.4	30.1	45.1	9.4	1.56	13,000	51,000	.688	.146	10,820	.098	819	11,639	16,000	4,361	.457	20.20
2.6	32.6	47.6	8.9	1.52	14,120	49,880	.673	.144	10,670	.094	875	11,545	15,850	4,305	.462	22.10
2.8	35.1	50.1	8.2	1.44	14,850	49,150	.663	.138	10,230	.088	905	11,135	15,650	4,515	.441	22.70
3.0	37.6	52.6	7.6	1.39	15,800	48,200	.650	.131	9,700	.084	954	10,654	15,450	4,796	.415	22.80
3.5	43.9	58.9	6.5	1.28	18,200	45,800	.618	.111	8,230	.077	1,095	9,325	15,000	5,675	.351	22.60
4.0	50.2	65.2	5.9	1.23	21,400	42,600	.575	.101	7,490	.075	1,308	8,798	14,450	5,652	.352	25.90
4.5	56.5	71.5	5.7	1.21	25,350	38,650	.522	.093	6,890	.073	1,530	8,420	13,950	5,530	.360	29.90
5.0	62.8	77.8	5.8	1.22	30,300	33,700	.455	.088	6,520	.074	1,835	8,355	13,450	5,095	.391	36.00
6.63	83.2	98.2	10.1	1.62	64,000	0	0	0	0	.105	4,150	4,150	11,650	7,500	.266	38.30

$C_V = V_k$fps./ $\sqrt{gb}$
$C_\Delta = \Delta/wb^2$
$C_R = R/wb^2$
V_k = Water speed

* Use full ground effect.
$V_k$mph. = C_V x 12.55
C_Δ = Δ/ 74090
R = C_R x 74090
V/a = Airspeed

$L = .00256 C_L S V_o^2 = C_L V_{o2}$ x 4.10
$D = .00256 C_D S V_o^2 = C_D V_{o2}$ x 4.10
$1/a$ = GW./gT_o = $1{,}990/T_o$

20) this time is reduced to 38.1 sec.

Using Diehl (Fig. 19) and given that the wind, V_w, is 15 mph. and the getaway speed V_G (from the example) is 98.2 mph., the ratio V_w/V_G is 0.153. If the zero wind takeoff time is again 48.7 sec., Fig. 19 gives 37 sec. at a ratio of $V_w/V_G = 0.153$, which corresponds to a 15-mph. headwind. This value is found to be approximately 3 percent too low. For the establishing of guarantees this error could very reasonably be critical.

Using Jones' formula (equation 73) and given the values of the example we have:

$$\frac{t_w}{48.7} = \left(1 - \frac{15}{98.2}\right) \qquad (76)$$

solving for t_w gives a takeoff time of 41.3 sec., which is found to be 8.4 percent too high. Likewise, employing Jones' formula for distance,

$$\frac{S_w}{3820} = \left(1 - \frac{15}{98.2}\right)^2 \qquad (77)$$

and solving for S_w we obtain a takeoff distance with a 15-mph. headwind of 2,740 ft., whereas the integrated distance from Fig. 21 is 2,620 ft., or an error of 4.6 percent.

To illustrate the deviation between the various methods, particularly in the range of takeoff times of over a minute, a correction curve for each method has been presented in Fig. 22 for the one case of a headwind equal to 20 percent of the getaway speed. This figure shows that the integrated method is approximately half way between those of Diehl and Jones except in the region of higher times, where Diehl shows considerable divergence. This is a particularly severe condition of headwind and was picked for illustration purposes. As wind decreases, divergence of the curves rapidly decreases.

Air Carrier Stocks

(*Continued from page* 188)

necessary statistics and data to make an impressive case for the requested franchises is greater than the layman might suppose. Then later come the hearings, with all the attendant legal expenses. All this expansion expense mounts up into large sums for every line.

As to the longer term outlook on earnings: While costs have been cut appreciably, it cannot be said the lines are in a wholly satisfactory state from the standpoint of early postwar revenues. The carriers will enter the transition period of competitive peacetime conditions from a wartime status where there was more traffic than could be handled.

The passenger load factor has skyrocketed from less than 60 percent before Pearl Harbor to a present average of better than 90 percent. But the industry quite generally expects this percentage to drop back to less than 60 again after the war, even if passenger revenue still continues to increase. That situation, of course, can be aggravated by a too rapid expansion in transport fleets.

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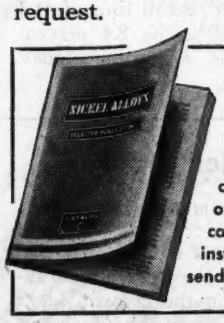

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set promptly by cuts in unit operating costs because of the inevitable wartime expansion of personnel. As mentioned earlier, some of the lines have been pruning their organizations. But an understandable tendency exists in every company to retain the best of the war-trained personnel against the day when these experienced men will be sorely needed. With their era of greatest expansion lying ahead, no airline is likely to shrink its staff back to anything like its prewar size.

Cargo and Airmail Futures

Not many trade officials are willing to hazard a guess on postwar passenger traffic volume, but many of them are in complete agreement that freight and express will not contribute very appreciably to revenues *directly* after the war. They feel that the wartime peaks attained in this category may not be reached again for a number of years. Furthermore, they have yet to hear of a cargo plane with ton-mile operating costs low enough to compete seriously with the rates of the railroads.

Then there is the airmail question. Don't forget that it is only within the last three years that the airline industry has been able to operate at a profit independent of airmail. The reduction in airmail rates last year cut mail revenues as much as 50 percent in some cases. In the early peacetime years this reduction alone may prevent the smaller lines from making a profitable showing unless some relief rate-wise is provided by the CAB.

Postwar Financial Possibilities

Then there are many financial angles to be considered with respect to the coming peacetime expansion. It is concededly a great feather in the cap of the small line that gets a franchise to operate in major traffic areas like New York and Chicago. But every such line realizes that it will run smack up against the entrenched large lines with their lower costs. And the larger lines, too, will see their expenditures grow by leaps and bounds as they invade new territory. Many millions will have to be expended to develop feeder territory along trunk routes. Much of this expenditure will occur before the new routes begin to be profitable, and not all of it can be capitalized.

Thus the indications pretty much all point to smaller earning power for the airlines during the transitional period that will follow the war. Against this must be weighed the offsetting—and very favorable—factor of unusual growth possibilities. The stock market has always placed a high appraisal on any industry that is just beginning to go places, as witness the chemical industry.

But even in the case of the more matured chemical industry with its greatest developments in the plastics field still ahead, it can be noted that these highly favored chemical stocks did not budge last spring when the market was advancing almost daily to new high ground for the year. The reason: Chemical issues had begun to bounce back from their wartime peaks in earning power.

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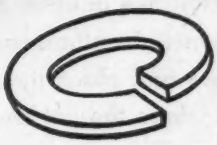

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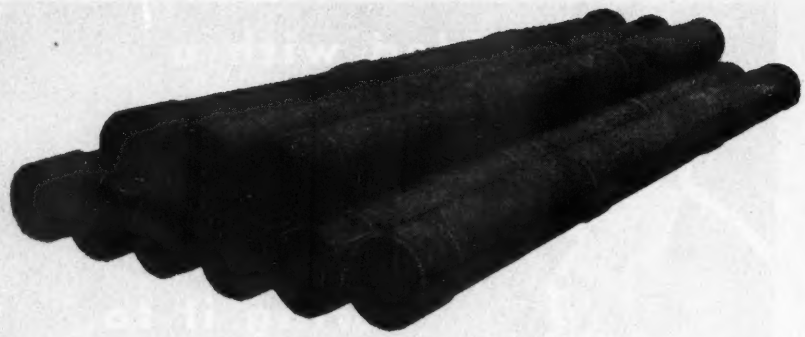

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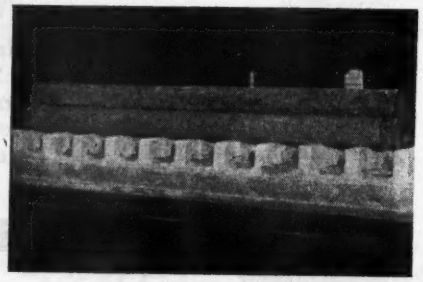

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His Honor Says

(*Continued from page* 177)

damages accruing to the remainder of the land. The owner of the land is treated as one offering it for sale at a fair price and the condemner is treated as a prospective buyer, neither party being under any stress which would force the sale or purchase. Since the seller in such a transaction would take into consideration damage to the remainder of his land in selling part thereof, so the law, in fixing his compensation, bases his damage on the same consideration.

In *State* v. *Rascoe,* it was disclosed that the Rascoe farm comprised 378 acres located about three miles from a city. Upwards of 3,000 acres in the neighborhood were acquired by the state for use by the government as an airbase. Some 44 acres of the Rascoe farm were appropriated. Rascoe sued, and the lower court rendered a verdict in his favor for $5,700 actual damages and also $12,000 incidental damages.

The state appealed and proved that although the land was fertile, well fenced, and quite desirable property, it was located on a graveled road, and actual sale value was approximately $125 per acre. The higher court approved the verdict and stated that $12,000 incidental damages was not excessive for damage to the remainder of the farm.

Pilot Liability

A pilot is not always liable because of an accident while piloting a plane without a license.

In *Smith* v. *Whitley,* it was shown that a pilot of a crashed plane had carried a passenger without a license to do so. The injured passenger sued the pilot and owner of the plane for damages alleging violation of the law by piloting without proper license. The court refused to agree, saying:

"There must be a causal connection between the violation of the law, as the negligence relied upon, and the injury inflicted."

Airport Operator Liable

Courts hold that changes in weather conditions, which airport operators are bound to anticipate as likely to occur, must be anticipated to avoid damages.

In *Zanker* v. *Cedar Flying Service,* it was shown that the owner sued to recover the value of his Piper *Cub,* which was destroyed by a windstorm at a flying field while the plane was in the possession of the operator of the field. During the trial, testimony was presented which proved that the plane had been used by its owner that morning and was not in the hangar but on the field with its wheels blocked. It was not anchored or tied down.

The evidence tended to show that there was room for the plane in the hangar but that the doorways to the hangar were obstructed by large planes upon which repair work was being done. The weather was threatening, but the thunderstorm and wind squall that damaged the plane did not develop until about noon. Holding the airport operator liable, the higher court said:

"Care, and the effect of high or squally winds upon a plane as light as a Piper *Cub* must be taken into account. We think the evidence was ample to sustain a finding of negligence on the part of defendant (airport owner)."

Exclusive Concession

A city ordinance concerned with an exclusive concession is valid if authorized by state laws and legally enacted.

In *Blue Bird Air Service* v. *City of Chicago*, it was shown that the commissioner of public works advertised for proposals for a concession for exclusive operation of sightseeing planes at the Chicago Municipal Airport for a period of four years, according to the specifications on file in his office.

The highest bidder was the Monarch Air Service, which was granted the concession. The contract was approved by the city council. Later, Blue Bird Air Service filed suit and requested an injunction against enforcement of the contract and to restrain the commissioner from interfering with its operation of an air sightseeing business originating from the airport.

The lower court refused to grant the injunction, and the higher court approved the decision.

Pilot Restricted

In *Cameron* v. *Civil Aeronautics Board*, it was revealed that a pilot had flown an army plane acrobatically over and within 1,000 ft. horizontally of the Indianapolis airport. Also, he performed a dive followed by a steep climbing turn over buildings located on the airport. The CAB restricted his airline transport pilot's certificate for 30 days, permitting him to pilot aircraft during that time only while engaged in experimental work directly under the orders and control of the War Department. On appeal, the court held:

"True, Cameron (pilot) was acting under army orders and was flying an army plane, but on this flight his orders were to fly according to contact flight rules in accordance with Civil Air Regulations. There is no conflict between the regulations and the army orders or army flight instructions."

A Child Shall Fly Them

(*Continued from page* 111)

education. The plan prepared at this conference recommended 4 hr. of flight experience as the laboratory feature to complement a general course in aeronautics in the secondary schools.

Pennsylvania is not alone in the tendency to incorporate flight training in the high schools. The Wisconsin State Department of Public Instruction has submitted to the local education authorities of that state, a comprehensive report concerning recommended aviation programs. Included is the suggestion of an operator-educator tieup for presenting approximately 4 hr. of flight experience as a laboratory phase of an aeronautics course.

It is to be noted, however, that such

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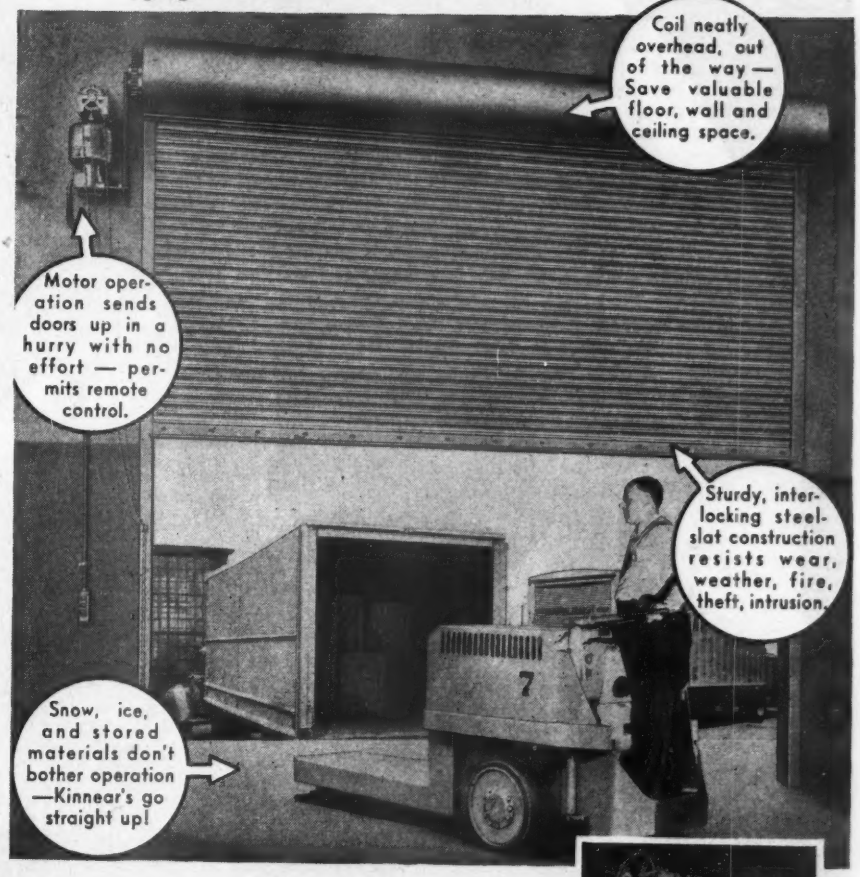
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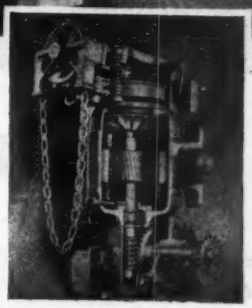

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"flight experience" is differentiated from "flight instruction" in that it means riding in an airplane piloted by a flight instructor. As stated in the Wisconsin report, this is considered a minimum definition, for it is anticipated that many students will be regarded as capable of operating a set of dual controls during part of their time in the air.

Question of Obligations

But there is a vast gap between being considered capable to fly and the act of having demonstrated ability to do so. The flight experience likely will consist of a cross-country hop, interpretation of instrument readings, solution of avigation problems, checking of meteorlogical data, and familiarization with controls as an incidental feature. However, it is felt in some quarters that such flight experience, though a commendable contribution to the tempo of the times, stops short of educational obligations.

It is considered by many that it is the apparent responsibility of every educational community in each state to include, as a contribution to a vast national reservoir of potential pilot strength, not only a general aeronautics course as a vital part of its secondary school curriculum, but also flight instruction as a necessary complement thereto. Compulsory military training, if it comes, would probably designate the secondary school as its focal point for a military aviation screening process for more advanced training.

Had there been a national capability of young boys and girls to fly as a result of primary training in the high schools, the consequent acceleration of the AAF training programs and the contribution to the war effort in general would have been of tremendous value.

And since the importance of flight training is recognized by educators, it seems uneconomical to allot 4 hr. to "flight experience" when "flight instruction" could just as well be given in that time, and would require nothing additional over the airplane, instructor, fuel, maintenance, and insurance required for giving flight experience.

May Rouse Federal Interest

Furthermore, it is not improbable that with sufficient initiative demonstrated by educators, Federal interest may result in financial aid, and even may make possible the attainment of sufficient increments of flying time up to date of graduation, to enable a student to be eligible to qualify for a private pilot's license.

There is an immediate urgency of educational readjustment to meet the changes brought by the advances in aviation. There are but few fundamental studies in the secondary schools which are not affected or enriched by the field of aviation.

Since the secondary school is the highest basic universal medium of education, opportunity should be given there for the young student to obtain a knowledge of aeronautics complete with flight instruction, for many will not be financially able to continue with specialized college study or be able to obtain flight training on their own. Also, since the high school

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student is at an impressionable age, it may well be that any characteristic of diffidence would be dispelled and supplanted by a sense of self reliance as a result of flight instruction, for there is probably no better way to instill confidence than to have a youngster discover that he can pilot a plane.

Flight instruction is not entirely new in high school curriculum. As early as 1934, such instruction, the follow-up of glider-training three years earlier, was successfully afforded boys and girls of the Teaneck, N. J., high school. However, this training was conducted on a somewhat small scale and limited by scholarship. Flight instruction was presented outside of school hours, and time was given for each dollar contribution on a sliding scale depending on monthly operating outlay divided into flying hours. Hangar rent and gas and oil expense were defrayed at cost by flight student payments. (See "Tomorrow's Pilots," page 27, July 1933 AVIATION.)

For the flight school operator, flight instruction in the secondary schools offers an extensive and lucrative market. The operator's capability and logical nomination for such secondary school training phase has been strikingly demonstrated by the great number of operator-trained army and navy pilots and the safety records achieved under the WTS programs. High school students will require the same high teaching standards, and the flight instructor will have to be temperamentally fitted for the job.

Flight instruction in a small educational community might entail a financial disadvantage for the operator. However, servicing a combination of such communities would offer a compensating advantage. In the largest communities, where high school enrollment runs into thousands a profitable return is apparent. The educational activity could complement the usual operator features of flight instruction, renting planes, selling parts, servicing, and accommodation of transients. Additional income would probably come from continuation of flying resulting from student interest created.

But the situation is not one of "come and get it". Though the trend seems inevitable, there is pioneering to be done by the operator to capitalize on this opportunity—which it is up to him to go and get.

Book Reviews

(*Continued from page* 197)

sented in a manner which permits direct utilization of the stress-strain diagram in strength calculations. The text is supplemented with problems; calculus and advanced mathematical methods have, however been avoided.

THE AIRCRAFT YEAR BOOK FOR 1944, edited by Howard Mingos. Lancair Publishers, N. Y. $6.

Annual official publication of the Aeronautical Chamber of Commerce, this volume, designed as a reference and record of American aviation, is packed with factual data on every phase of aviation.

The material is divided into three main parts. First section comprises 10 chapters, 9 of which cover: (1) The air war, (2) America's record in the building of

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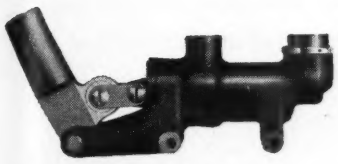

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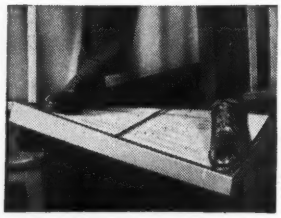

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allied air superiority, (3) AAF, (4) U. S. Naval aviation, (5) Civil Air Patrol, (6) war air transport, (7) war training programs, (8) work of federal aviation bureaus, and (9) aeronautical organizations. The tenth chapter, **New Things in the Air**, recounts the new developments by American aircraft, engine, and accessory manufacturers who have contributed to the striking power of allied air forces. The directory, second of these parts, lists aeronautical equipment and organizations.

Concluding section covers facts and figures on air carrier operations, labor, American warplanes, airports and landing fields, and numerous other subjects. Volume is profusely illustrated and completely indexed.

GAS TURBINES AND JET PROPULSION FOR AIRCRAFT, by G. Geoffrey Smith, M.B.E. Flight Publishing Co., Ltd., London, England. 117 pages, illustrations, index. 6/—($1.20).

A timely volume on aircraft propulsion plants employing combustion gas turbines and rotary compressors. Early background material is considered, with short biographical sketches of Whittle, Carter, and Sayer, the British technicians who developed gas turbine units to a practical stage.

Material covered includes thermal jet propulsion systems with rotary, reciprocating, and combined power units, also a survey of steam and gas turbines driving airscrews. Chapters are also devoted to the influence of jet systems on aircraft design and to a discussion of Italian jet propulsion experiments.

MAN'S FIGHT TO FLY, by John P. V. Heinmuller. Funk & Wagnalls Co., N. Y. 380 pages, index. $6.

"This book aims to illuminate the greatest physical conquest over space and time, namely, the conquest of the air, as shown by man's ability to fly, and to honor and record those pioneers who through their life work and experience have left a definite imprint on the history of aviation."

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A foreword by Eddie Rickenbacker states that here are "historical facts that should be read by every man, woman, and child in America." Those associated with aviation during the record-flight years will especially enjoy the book for the many memories brought back by the more than 200 documental photos.

HANDBOOK OF AIR NAVIGATION, by W. J. Vanderkloot. McGraw-Hill Book Co., N. Y. 298 pages, appendices, index. $3.

Complete manual on avigation based on the standards required by the International Committee of Air Navigation for the carriage of passengers between foreign countries. It is the belief of the author that the CAA will have to establish avigational licenses for avigators engaged in postwar international air transport.

Although this volume is based on present British standards, it is probable that future CAA regulations will not differ greatly. All map-reading and astronomical aids to avigation are covered, with special attention to the value of two-position line and three-position line fixes. Added feature is appendix giving necessary formulas and mathematical calculations.

THE WILD BLUE YONDER, by Emile Gauvreau. E. P. Dutton & Co., N. Y. 369 pages, index. $3.

The author, associate of Gen. Billy Mitchell, reveals how neglect of airpower almost brought us to the edge of disaster; for, after Pearl Harbor, General Arnold's official report states we had only 176 combat planes to defend the whole sweep of the Pacific from Hawaii to Singapore. The volume is designed to give an understanding of the vast part air power is playing in our present offensives.

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